FBISE

PHYSICS

MODEL PAPERS & GUESS PAPERS

Faderal Board Islamabad

Presented by:

Urdu Books Whatsapp Group

STUDY GROUP

9TH CLASS

0333-8033313
راؤ ایاز

0343-7008883
پاکستان زندہ باد

0306-7163117
محمد سلمان سلیم

UNIT 1: PHYSICAL QUANTITIES AND MEASUREMENTS

1.2. Physical quantities
1.3. International system of units
1.4. Prefixes
1.5. Scientific Notation
1.6. Measuring Instruments (Vernier callipers, Screw gauge, Stop Watch only)
(Tables: 1.2, 1.3, 1.4 included)

NOTE:

- All mini exercises, quick quiz and side information are excluded.
- Only topic based related MCQs, Short and Long Questions and numerical are included.

GUESS PAPER & MODEL PAPER # 1
BASED ON UNIT # 1 (Reduced Syllabus)
PHYSICAL QUANTITIES AND MEASUREMENT

SECTION-A

Time allowed: 20 Minutes **Marks: 12**

Note: Section-A is compulsory. All parts of this section are to be answered on the question paper itself. It should be completed in the first 20 minutes and handed over to the Centre Superintendent. Deleting/overwriting is not allowed. Do not use lead pencil.

Q.1 Encircle the correct option i.e. A / B / C / D. All parts carry equal marks.

i. The number of base units in SI are:
A. 3 B. 6 C. 7 D. 9

ii. Which one of the following unit is not a derived unit?
A. pascal B. kilogram C. newton D. watt

iii. Amount of a substance terms of numbers is measured in:
A. gram B. kilogramn C. newton D. mole

iv. An interval of 200 μs equivalent to
A. 0.2 s B. 0.02 s C. 2×10^{-4} s D. 2×10^{-6} s

v. Which one of the following the smallest quantity?
A. 0.01 g B. 2 mg C. 100 μg D. 5000 ng

vi. Which instrument is most suitable to measure the internal diameter of a test tube?
A. metre rule B. Vernier Callipers
C. measuring tap D. screw gauge

vii. A student claimed the diameter of a wire as 1.032 cm using Vernier Callipers up to what extent do you agree with it?
A. 1 cm B 1.0 cm C 1.03 cm D. 1.032 cm

ختم نبوت ﷺ زندہ باد

عظمت صحابہ زندہ باد

السلام علیکم ورحمۃ اللہ وبرکاتہ:

معزز ممبران: آپ کا وٹس ایپ گروپ ایڈ من "**اردو بکس**" آپ سے مخاطب ہے۔

آپ تمام ممبران سے گزارش ہے کہ:

- گروپ میں صرف PDF کتب پوسٹ کی جاتی ہیں لہذا کتب کے متعلق اپنے کمنٹس / ریویوز ضرور دیں۔ گروپ میں بغیر ایڈ من کی اجازت کے کسی بھی قسم کی (اسلامی و غیر اسلامی، اخلاقی، تحریری) پوسٹ کرنا سختی سے منع ہے۔
- گروپ میں معزز، پڑھے لکھے، سلجھے ہوئے ممبرز موجود ہیں اخلاقیات کی پابندی کریں اور گروپ رولز کو فالو کریں بصورت دیگر معزز ممبرز کی بہتری کی خاطر ریموو کر دیا جائے گا۔
- کوئی بھی ممبر کسی بھی ممبر کو انباکس میں میسیج، مس کال، کال نہیں کرے گا۔ رپورٹ پر فوری ریموو کر کے کاروائی عمل میں لائے جائے گی۔
- ہمارے کسی بھی گروپ میں سیاسی و فرقہ واریت کی بحث کی قطعاً کوئی گنجائش نہیں ہے۔
- اگر کسی کو بھی گروپ کے متعلق کسی قسم کی شکایت یا تجویز کی صورت میں ایڈ من سے رابطہ کیجئے۔
- سب سے اہم بات:

گروپ میں کسی بھی قادیانی، مرزائی، احمدی، گستاخِ رسول، گستاخِ امہات المؤمنین، گستاخِ صحابہ و خلفائے راشدین حضرت ابو بکر صدیق، حضرت عمر فاروق، حضرت عثمان غنی، حضرت علی المرتضیٰ، حضرت حسنین کریمین رضوان اللہ تعالیٰ اجمعین، گستاخ اہلبیت یا ایسے غیر مسلم جو اسلام اور پاکستان کے خلاف پراپیگنڈا میں مصروف ہیں یا ان کے روحانی و ذہنی سپورٹرز کے لئے کوئی گنجائش نہیں ہے لہذا ایسے اشخاص بالکل بھی گروپ جوائن کرنے کی زحمت نہ کریں۔ معلوم ہونے پر فوراً ریموو کر دیا جائے گا۔

- تمام کتب انٹرنیٹ سے تلاش / ڈاؤنلوڈ کر کے **فری آف کاسٹ** وٹس ایپ گروپ میں شیئر کی جاتی ہیں۔ جو کتاب نہیں ملتی اس کے لئے معذرت کر لی جاتی ہے۔ جس میں محنت بھی صَرف ہوتی ہے لیکن ہمیں آپ سے صرف دعاؤں کی درخواست ہے۔
- عمران سیریز کے شوقین کیلئے علیحدہ سے عمران سیریز گروپ موجود ہے۔

لیڈیز کے لئے الگ گروپ کی سہولت موجود ہے جس کے لئے ویریفکیشن ضروری ہے۔

- اردو کتب / عمران سیریز یا سٹڈی گروپ میں ایڈ ہونے کے لئے ایڈ من سے وٹس ایپ پر بذریعہ میسج رابطہ کریں اور جواب کا انتظار فرمائیں۔ برائے مہربانی اخلاقیات کا خیال رکھتے ہوئے موبائل پر کال یا ایم ایس کرنے کی کوشش ہر گز نہ کریں۔ ورنہ گروپس سے تو ریموو کیا ہی جائے گا بلاک بھی کیا جائے گا۔

[redacted]

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اللہ تبارک تعالیٰ ہم سب کا حامی و ناصر ہو

ختم نبوت ﷺ زندہ باد

عظمت صحابہ زندہ باد

السلام علیکم ورحمۃ اللہ وبرکاتہ:

معزز ممبران: آپ کا وٹس ایپ گروپ ایڈ من "**اردو بکس**" آپ سے مخاطب ہے۔

آپ تمام ممبران سے گزارش ہے کہ:

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- کوئی بھی ممبر کسی بھی ممبر کو انباکس میں میسیج، مس کال، کال نہیں کرے گا۔ رپورٹ پر فوری ریموو کر کے کاروائی عمل میں لائے جائے گی۔
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- تمام کتب انٹرنیٹ سے تلاش / ڈاؤنلوڈ کر کے **فری آف کاسٹ** وٹس ایپ گروپ میں شیئر کی جاتی ہیں۔ جو کتاب نہیں ملتی اس کے لئے معذرت کر لی جاتی ہے۔ جس میں محنت بھی صَرف ہوتی ہے لیکن ہمیں آپ سے صرف دعاؤں کی درخواست ہے۔
- عمران سیریز کے شوقین کیلئے علیحدہ سے عمران سیریز گروپ موجود ہے۔
- **لیڈیز کے لئے الگ گروپ کی سہولت موجود ہے جس کے لئے ویریفکیشن ضروری ہے۔**
- اردو کتب / عمران سیریز یا سٹڈی گروپ میں ایڈ ہونے کے لئے ایڈ من سے وٹس ایپ پر بذریعہ میسیج رابطہ کریں اور جواب کا انتظار فرمائیں۔ برائے مہربانی اخلاقیات کا خیال رکھتے ہوئے موبائل پر کال یا ایم ایس کرنے کی کوشش ہر گز نہ کریں۔ ورنہ گروپس سے تو ریموو کیا ہی جائے گا بلاک بھی کیا جائے گا۔

نوٹ: ہمارے کسی گروپ کی کوئی فیس نہیں ہے۔ سب فی سبیل اللہ ہے

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اللہ تبارک تعالیٰ ہم سب کا حامی و ناصر ہو

ix. A student noted the thickness of a glass sheet using a screw gauge. On the main scale, it reads 3 divisions while 8th division on the circular scale coincides with index line. Its thickness is:

A. 3.8 cm B 3.08 mm C. 3.8 mm D. 3.08 m

x. Significant figures in an expression are:

A. all the digits
B. all the accurately known digits
C. all the accurately known digits and the first doubtful digit
D all the accurately known and all the doubtful digits

xi. least count of screw gauge is _____.

A. 0.1 cm B. 0.0001 mm C. 0.01 mm D. 0.001 mm

xii. least count of vernier calliper is _____.

A 0.1 cm B. 0.0001 mm C. 0.01 cm D. 0.001 mm

Time Allowed: 2:40 Minutes **Total Marks: 53**

Note: Answer any six parts from Section 'B' and attempt any five parts from Section-C. Attempt any two questions from Section 'D' on the separately provided answer book. Use supplementary answer sheet i.e. Sheet-B if required. Write your answers neatly and legibly

SECTION – B (Marks 18)

Q.2 Attempt any SIX parts from the following. All parts carry equal marks. (6 × 3 = 18)

(i) Estimate your age in seconds.

(ii) What is the difference between base quantities and derived quantities? Give three examples in each case.

(iii) Pick out the base units in the following:
joule, newton, kilogramme, hertz, mole, ampere, metre, kelvin, coulomb and watt.

(iv) Define unit?

(v) What do you understand by the zero error of a measuring instrument?

(vi) Express the following quantities using prefixes.
(a) 5000 g (b) 2000000 W (c) 52×10^{-10} kg (d) 225×10^{-8} s

(vii) Write the following quantities in standard form.
(a) 6400 km (b) 38000 km (c) 300000000 ms^{-1} (d) seconds in a day

(viii) Rewrite the following in standard form. (Scientific notation)
(a) 1168×10^{-27} (b) 32×10^{5} (c) 725×10^{-5} kg (d) 0.02×10^{-6}

SECTION – C (Marks 15)

Q.3 Attempt any FIVE parts from the following. All parts carry equal marks. (5 × 3 = 15)

(i) Write the numbers given below in scientific notation. 0.0000000016 g

(ii) What do you understand by scientific notation?

(iii) What is Prefixes and give examples?

(iv) What are the main advantages of system international (SI units)?

(v) A screw gauge has 50 divisions on its circular scale. The pitch of the screw gauge is 0.5mm. What is its least count?

(vi) Explain with examples that science is based on physical quantities which consist of numerical magnitude and a unit.

(vii) List the seven units of System international (SI) along with their symbols and physical quantities?

SECTION – D (Marks 20)

(b) On closing the jaws of a Vernier Callipers, zero of the vernier scale is on the right to its main scale such that 4th division of its vernier scale coincides with one of the main scale division. Find its zero error and zero correction.

Q.5 (a) Describe the construction and working of screw gauge?

(b) How do the prefixes micro, nano and pico relate to each other?

Q.6 (a) What is a stopwatch? What is the least count of a mechanical stopwatch you have used in the laboratories?

(b) Your hair grow at the rate of 1 mm per day. Find their growth rate in nm s^{-1}.

SOLUTION OF GUESS PAPER & MODEL PAPER # 1
(Reduced Syllabus)

SECTION- A (MCQs)

i. C	ii. B	iii. D	iv. C	v. D	vi. B
vii. C	viii. B	ix. B	x. C	xi. C	xii. C

SECTION – B (Marks 18)

Q.2 Attempt any SIX parts from the following. All parts carry equal marks. (6 × 3 = 18)

(i) Estimate your age in seconds.

Ans: Suppose my age = 15 years

= 15 × 365 = 5475 days ; (∵ 1 year = 365 days)

= 5475 × 24 = 131400 hours ; (∵ 1 day = 24 Hours)

= 131400 × 60 = 7884000 minutes ; (∵ 1 hour = 60 Minutes)

= 7884000 × 60 = 473040000 seconds ; (∵ 1 minute = 60 second)

(ii) What is the difference between base quantities and derived quantities? Give three examples in each case.

Ans: **Difference between base quantities and derived quantities:**

Base quantities:

Base quantities are the quantities on the basis of which other quantities are expressed.
There are seven physical quantities which form the foundation for other physical quantities.
These physical quantities are called the base quantities.

Examples:

Length, mass, time, electric current, temperature, intensity of light and the amount of a substance.

Derived quantities:

The quantities that are expressed in terms of base quantities are called derived quantities.

Examples: Area, volume, speed, force, work, energy, power, electric charge, electric potential, etc.

(iii) Pick out the base units in the following:
joule, newton, kilogramme, hertz, mole, ampere, metre, kelvin, coulomb and watt.

Ans: **Base units:**
kilogramme, mole, ampere, metre, Kelvin.

(iv) Define unit?

Ans: **Unit:**
Once a standard is set for a quantity then it can be expressed in terms of that standard quantity. This standard quantity is called a unit.

(v) What do you understand by the zero error of a measuring instrument?

Ans: **Zero Error and Zero Correction:**

For Example:

To find the zero error, close the jaws of Vernier Calipers gently. If zero line of the vernier scale coincides with the zero of the main scale then the zero error is **zero**. Zero error will exist if zero line of the vernier scale is not coinciding with the zero of main scale.

(vi) Express the following quantities using prefixes.

(a) 5000 g **(b) 2000000 W**

(c) 52×10^{-10} kg **(d) 225×10^{-8} s**

Solution:

(a) 5000 g

$= 5 \times 1000$g $= 5 \times 1$kg (Since 1000 g = 1 kg) $= 5$ kg

(b) 2000,000 W

$= 2 \times 1000000$ $= 2 \times 10^6$ W $= 2 \times$ Mega W ($\because 10^6 = 1$Mega) $= 2$ MW

(c) 52×10^{-10} kg

$= 5.2 \times 10 \times 10^{-10}$ kg $= 5.2 \times 10^{-9}$ kg $= 5.2 \times 10^{-9} \times 1000$ g (Since 1 kg = 1000 g)

$= 5.2 \times 10^{-9} \times 10^3$ g $= 5.2 \times 10^{-6}$ g $= 5.2\ \mu$g [$\because 10^{-6} = 1$micro (μ)]

(d) 225×10^{-8} s

$= 2.25 \times 10^2 \times 10^{-8}$ s $= 2.25 \times 10^{-6}$ s $= 2.25\ \mu$s [$\because 10^{-6} = 1$micro (μ)]

(vii) Write the following quantities in standard form.

(a) 6400 km (b) 38000 km (c) 300000000 ms^{-1} (d) seconds in a day

Solution: (a) 64000 km

Multiplying and dividing by "10^3"

$$= \frac{6400\text{ m}}{1000} \times 10^3\text{km} \quad = \frac{64\text{ m}}{10} \times 10^3\text{km} = 6.4 \times 10^3\text{km}$$

(b) 38000 km

Multiplying and dividing by "10^5"

$$= \frac{38000}{10^5} \times 10^5\text{km} \quad = \frac{380000}{10^5} \times 10^5\text{km} \quad = 3.8 \times 10^5\text{km}$$

(c) 300000000 ms^{-1}

Multiplying and dividing by "10^8"

$$= \frac{300000000\text{ ms}^{-1}}{100000000} \times 10^8\text{km} \quad = 3 \times 10^8\text{km}$$

(d) seconds in a day

As we know

1 day = 24 hours $\Rightarrow$ 1 hour = 60 minutes $\Rightarrow$ 1 minute = 60 seconds So

1 day = 24 × 60 × 60 seconds $\Rightarrow$ 1 day = 86400 s $\Rightarrow$ 1 day = 86400 s

Multiplying and dividing by 10^4

$$= \frac{86400}{10000} \times 10^4\text{ s} \quad = 8.64 \times 10^4\text{ s}$$

(viii) Rewrite the following in standard form. (Scientific notation)

(a) 1168×10^{-27} (b) 32×10^5 (c) 725×10^{-5} kg (d) 0.02×10^{-8}

Solution: (a) $1168 \times 10^{-27} = 1.168 \times 10^3 \times 10^{-27} = 1.168 \times 10^{-24}$

(b) $32 \times 10^5 = 3.2 \times 10^1 \times 10^5 = 3.2 \times 10^6$

(c) 725×10^{-5} kg $= 7.25 \times 10^2 \times 10^{-5}$ kg $= 7.25 \times 10^{-3}$ kg As (10^{-3} kg = 1g), therefore 7.25×10^{-3} kg = 7.25 g

(d) $0.02 \times 10^{-8} = 2 \times 10^{-2} \times 10^{-8} = 2 \times 10^{-10}$

SECTION – C (Marks 15)

Q.3 Attempt any FIVE parts from the following. All parts carry equal marks. (5 × 3 = 15)

(ii) What do you understand by scientific notation?

Ans: Scientific notation/Standard form:

In scientific notation a number is expressed as some power of ten multiplied by a number between 1 and 10.

Examples:

a. The Moon is 384000000 metres away from the Earth. Distance of the moon from the Earth can also be expressed as $3.84 \times 10^8\ m$ This saves writing down or interpreting large numbers of zeros.

b. A number 62750 can be expressed as 6.275×10^4. Similarly the standard form of 0.00045 s is 4.5×10^{-4}s

(iii) What is Prefixes and give examples?

Ans: Prefixes:

Prefixes are the words or letters added before SI units such as kilo, mega, giga and milli.

SI units have the advantage that their multiples and sub-multiples can be expressed in terms of prefixes These prefixes are given in Table.

Some Prefixes

Prefix	Symbol	Multiplier
exa	E	10^{18}
peta	P	10^{15}
tera	T	10^{12}
giga	G	10^{9}
mega	M	10^{6}
kilo	K	10^{3}
hecto	H	10^{2}
deca	Da	10^{1}
deci	D	10^{-1}
centi	C	10^{-2}
milli	M	10^{-3}
micro	M	10^{-6}
nano	N	10^{-9}
pico	P	10^{-12}
femto	F	10^{-15}
atto	A	10^{-18}

(iv) What are the main advantages of system international (SI units)?

OR Why do we prefer SI units?

Ans: a. SI system is in use all over the world.

b. Manipulation in this system is quite easy i.e the multiple and sub multiple of different units are obtain simply by multiplying or dividing with ten or powers of tens.

(v) A screw gauge has 50 divisions on its circular scale. The pitch of the screw gauge is 0.5 mm. What is its least count?

Solution: Number of division on the circular scale = 50

Pitch of screw gauge = 0.5 mm

Least count of screw gauge L.C. = ?

$$\text{Least count} = \frac{Pitch}{Number\ of\ divisions\ on\ circular\ scale}$$

$$= 0.01 \text{ mm} = 0.01 \times \frac{1}{10} \text{ cm}$$

Least count = 0.001 cm

(vi) Explain with examples that science is based on physical quantities which consist of numerical magnitude and a unit.

Ans: Physical Quantities:

All measurable quantities are called physical quantities such as length, mass, time and temperature.

A physical quantity possesses at least two characteristics in common. One is its numerical magnitude and the other is the unit in which it is measured.


Measuring Height

Examples:

For example, if the length of a student is 104 cm then 104 is its numerical magnitude and centimeter is the unit of measurement.

Similarly when a grocer says that each bag contains 5 kg sugar, he is describing its numerical magnitude as well as the unit of measurement. It would be meaningless to state 5 or kg only.

Physical quantities are divided into base quantities and derived quantities.

(vii) List the seven units of System international (SI) along with their symbols and physical quantities?

Ans: International system of units:

The eleventh General Conference on Weight and Measures held in Paris in 1960 adopted a world-wide system of measurements called International System of Units. The International System of Units is commonly referred as SI.

Base units:

The units that describe base quantities are called base units. Each base quantity has its SI unit. Table shows *seven* base quantities, their SI units and their symbols.

Base quantities, their SI units with symbols

Quantity		Unit	
Name	Symbol	Name	Symbol
Length	*l*	metre	m
Mass	*m*	kilogramme	kg
Time	*t*	second	s
Electric current	I	ampere	A
Intensity of light	*L*	candela	cd
Temperature	*T*	kelvin	K
Amount of a substance	*n*	mole	mol

SECTION – D (Marks 20)

Note: Attempt any TWO questions. All questions carry equal marks. **(2 × 10 = 20)**

Q.4 (a) Describe the construction and working of vernier callipers?

Ans: Vernier callipers:

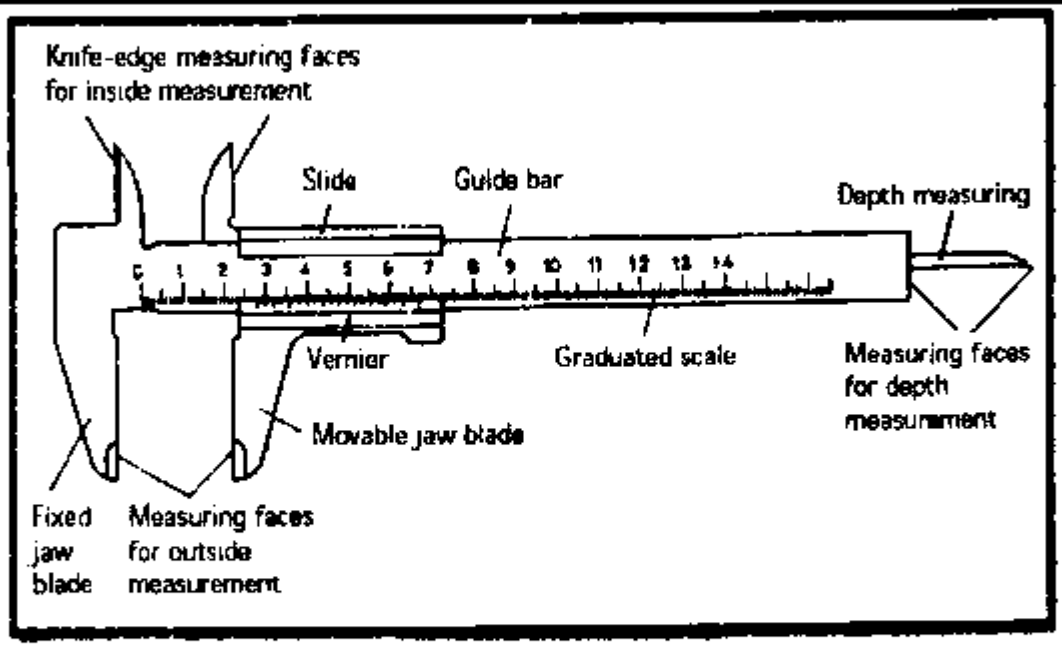
An instrument used to measure small lengths such as internal or external diameter or length of a cylinder, etc is called as Vernier Callipers.

Construction:

A Vernier Callipers consists of two jaws. One is a fixed jaw with main scale attached to it.

Main scale:

Main scale has centimeter and millimeter marks on it. The other jaw is a moveable jaw.



Least count (LC)/Vernier constant:

The difference between one small division on main scale division and one vernier scale division is 0.1 mm. It is called least count (LC) of the Vernier Callipers. Least count of the Vernier Callipers can also be found as given below:

$$Least\ count\ of\ Vernier\ Callipers = \frac{smallest\ reading\ on\ main\ scale}{number\ of\ divisions\ on\ vernier\ scale}$$

$$= \frac{1\,mm}{10\,division} = 0.1\,mm$$

Hence, $LC = 0.1\,mm = 0.01\,cm$

Working of a Vernier Callipers:

First of all find the error, if any, in the measuring instrument. It is called the zero error of the instrument. Knowing the zero error, necessary correction can be made to find the correct measurement. Such a correction is called zero correction of the instrument. Zero correction is the negative of zero error.

Taking a Reading on Vernier Callipers:

Let us find the diameter of a solid cylinder using Vernier Callipers. Place the solid cylinder between jaws of the Vernier Callipers. Close the jaws till they press the opposite sides of the object gently.

Note the complete divisions of main scale past the vernier scale zero in a tabular form. Next find the vernier scale division that is coinciding with any division on the main scale. Multiply it by least count of Vernier Callipers and add it in the main scale reading. This is equal to the diameter of the solid cylinder. Add zero correction (Z.C) to get correct measurement. Repeat the above procedure and record at least three observations with the solid cylinder displaced or rotated each time.

(b) On closing the jaws of a Vernier Callipers, zero of the vernier scale is on the right to its main scale such that 4th division of its vernier scale coincides with one of the main scale division. Find its zero error and zero correction.

Solution: **Main scale reading = 0.0 cm.**
Vernier division coinciding with main scale = 4th division
Vernier scale reading = 4 × 0.01 cm = 0.04 cm
Zero error = 0.0 cm + 0.04 cm = 0.04 cm
Zero correction (Z.C) = -0.04 cm

The zero error of the vernier scale is 0.04cm and its zero correction is -0.04cm

$$\left(\begin{matrix}vernier\ divison\ coinciding\\ with\ main\ scale\end{matrix}\right) = 4\ div$$

Zero correction is the negative of zero error. Thus
Zero error = +0.04 cm
and Zero correction = - 0.04 cm

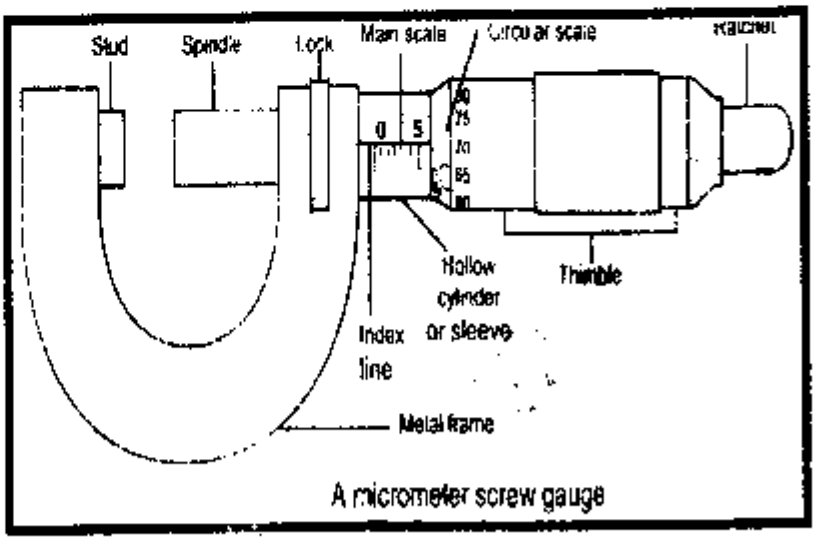
Q.5 (a) Describe the construction and working of screw gauge?

Ans: Screw gauge:

A screw gauge is an instrument that is used to measure small lengths with accuracy greater than a Vernier Calliper. It is also called as micrometer screw gauge.

Construction:

A simple screw gauge consists of a U-shaped metal frame with a metal stud at its one end. A hollow cylinder (or sleeve) has a millimetre scale over it along a line called index line parallel to its axis. The hollow cylinder acts as a nut. It is fixed at the end of U-shaped frame opposite to the stud. A Thimble has a threaded spindle inside it. As the thimble completes one rotation, the spindle moves 1 mm along the index line. It is because the distance between consecutive threads on the spindle is 1 mm. This distance is called the pitch of screw on the spindle



A micrometer screw gauge

Least count of screw gauge:

$$Least\ count = \frac{pitch\ of\ the\ screw\ gauge}{no.of\ division\ on\ circular\ scale} = \frac{1\ mm}{100} = 0.01\ mm = 0.001\ cm$$

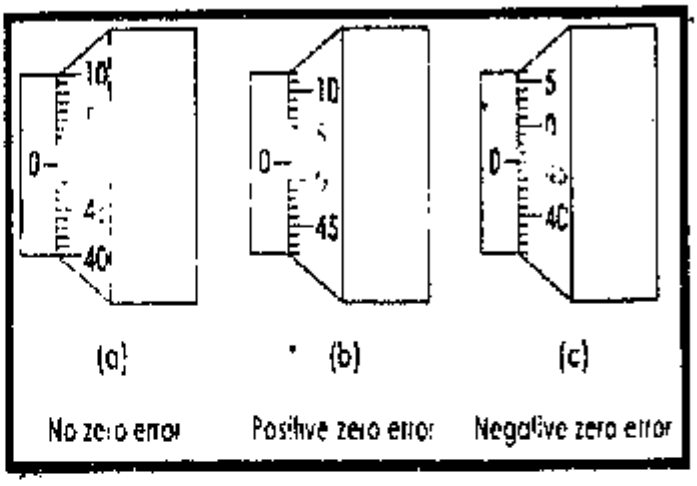
Thus least count of the screw gauge is 0.01 mm or 0.001 cm.

Working of a screw gauge:

The first step is to find the zero error of the screw gauge

Zero error:

To find the zero error, close the gap between the spindle and the stud of the screw gauge by rotating the ratchet in the clockwise direction. If zero of circular scale coincides with the index line, then the zero error will be zero.



Positive zero error:

Zero error will be positive if zero of circular scale is behind the index line. In this case, multiply the number of divisions of the circular scale that has not crossed the index line with the least count of screw gauge to find zero error.

Negative zero error:

Zero error will be negative if zero of circular scale has crossed the index line.

In this case, multiply the number of divisions of the circular scale that has crossed the index line with the least count of screw gauge to find the negative zero error

(b) How do the prefixes micro, nano and pico relate to each other?

Solution: As we know

micro = $\mu = 10^{-6}$ $\Rightarrow$ nano = n = 10^{-9} $\Rightarrow$ pico = p = 10^{-12}

The relation between micro, nano and pico can be written as

Q.6 (a) What is a stopwatch? What is the least count of a mechanical stopwatch you have used in the laboratories?

Ans: Stopwatch:

A stopwatch is used to measure the time interval of an event.

Types of stopwatch:

There are two types of stopwatches; mechanical and digital

Mechanical stopwatch:

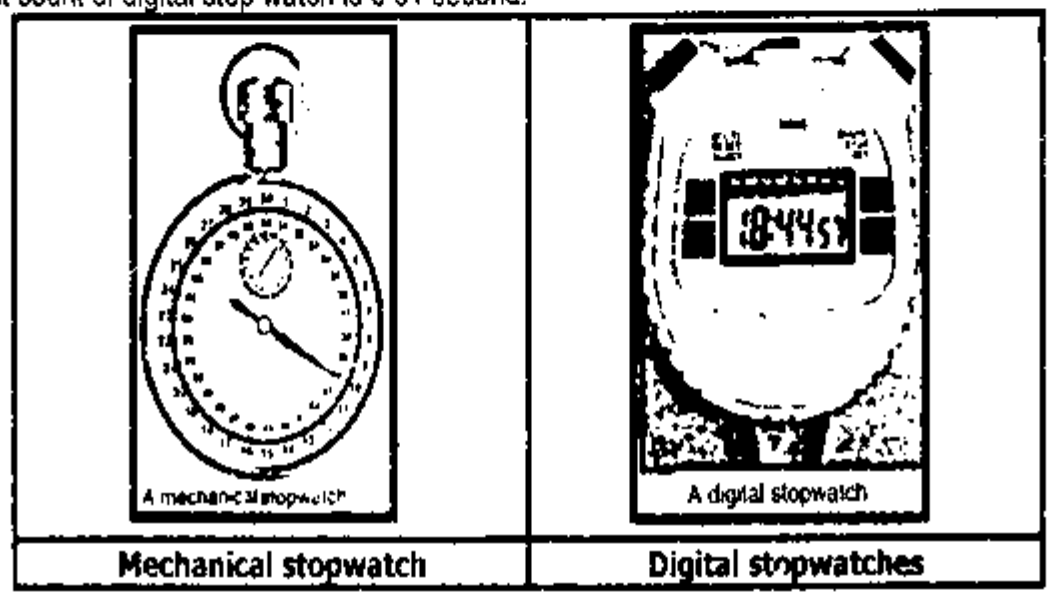
A mechanical stopwatch can measure a time interval up to a minimum 0.1 second.

Least count of mechanical stop watch is 0.1 second.

Digital stopwatches:

Digital stopwatches commonly used in laboratories can measure a time interval as small as 1/100 second or 0.01 second.

Least count of digital stop watch is 0.01 second.



Mechanical stopwatch	Digital stopwatches

How to use a Stopwatch:

Use of a mechanical stopwatch:

A mechanical stopwatch has a knob that is used to wind the spring that powers the watch. It can also be used as a start-stop and reset button. The watch starts when the knob is pressed once. When pressed second time, it stops the watch while the third press brings the needle back to zero position.

Use of a digital stopwatch:

The digital stopwatch starts to indicate the time lapsed as the start/stop button is pressed. As soon as start/stop button is pressed again, it stops and indicates the time interval recorded by it between start and stop of an event. A reset button restores its initial zero setting.

(b) Your hair grow at the rate of 1 mm per day. Find their growth rate in nm s^{-1}.

Solution: Growth rate of hair in nms^{-1} = 1mm per day

Growth rate of hair in one day = $24 \times 60 \times 60$ s

(Since 1 mm = 10^{-3} m and one day = $24 \times 60 \times 60$ s), hence

$$1 \text{ mm per day} = 1 \times 10^{-3} \text{ m} \times \frac{1}{24 \times 60 \times 60} \ s$$

$$= 1 \times 10^{-3} \text{ m} \times \frac{1}{8400} \ ms^{-1}$$

$$= 1 \times 10^{-3} \text{ m} \times 0.00001157$$

$$= 1 \times 10^{-3} \text{ m} \times 1157 \times 10^{-8} \ ms^{-1}$$

$$= 1157 \times 10^{-2} \text{ m} \times 10^{-9} ms^{-1}$$

$$= 11.57 \times 10^{-9} \text{ ms}^{-1}$$

1 mm per day = 11.57 nms^{-1}

IMPORTANT QUESTIONS

Q1. Explain with examples the derived units?

Ans: Derived units:

The units used to measure derived quantities are called derived units. Derived units are defined in terms of base units and are obtained by multiplying or dividing one or more base units with each other.

Examples:

i. The unit of area $(meter)^2$ and the unit of volume $(meter)^3$ are based on the unit of length, which is meter. Thus the unit of length is the base unit while the unit of area and volume are derived units.

ii. Speed is defined as distance covered in unit time; therefore its unit is meter per second. In the same way the unit of density, force, pressure, power etc. can be derived using one or more base units.

Derived quantities and their SI units with symbols

Quantity		Unit	
Name	Symbol	Name	Symbol
Speed	v	metre per second	ms^{-1}
Acceleration	a	metre per second per second	ms^{-2}
Volume	V	cubic metre	m^3
Force	F	newton	N or $(kg\ m\ s^2)$
Pressure	P	pascal	Pa or $(N\ m^{-2})$
Density	ρ	kilogramme per cubic metre	kgm^{-3}
Charge	Q	coulomb	C or (As)

Q2. What is zero error? How zero error is corrected?

OR

What do you understand by the zero error of a measuring instrument? Why is the use of zero error necessary in a measuring instrument?

Ans: Zero Error and Zero Correction:

To find the zero error, close the jaws of Vernier Callipers gently. If zero line of the vernier scale coincides with the zero of the main scale then the zero error is **zero**. Zero error will exist if zero line of the vernier scale is not coinciding with the zero of main scale

Positive zero error:

Zero error will be positive if zero line of vernier scale is on the right side of the zero of the main scale. To get the correct value zero error must be recorded and subtracted from each reading.

Negative zero error:

Zero error will be negative if zero line of vernier scale is on the left side of zero of the main scale. To get the correct value zero error must be recorded and add to each reading.

Q3. Find the base quantities involved in each of the following derived quantities:

(a) speed (b) volume (c) force (d) work

Ans: (a) speed:

$$\text{Speed} = \frac{\text{distance covered}}{\text{time taken}} \Rightarrow \text{Unit of speed} = \frac{\text{metre}}{\text{second}} = ms^{-1}$$

Base quantities involved in speed are metre and second

(b) Volume: Volume = length × width × height

Volume = m × m × m = m^3

Base quantity involved in volume is metre

(c) Force: $F = ma \Rightarrow 1N = 1\,kg \times 1\,ms^{-2} \Rightarrow$ or $1N = 1\,kgms^{-2}$

$1\,J = 1\,N \times 1\,m \Rightarrow 1\,J = 1\,kgms^{-2} \times 1\,m \Rightarrow 1\,J = 1\,kgm^2s^{-2}$

Base quantities involved in work are kilogramme, metre and second.

Q4. What role SI units have played in the development of science?

Ans: i. SI system is in use all over the world.

ii. Manipulation in this system is quite easy i.e. the multiple and sub multiple of different units are obtain simply by multiplying / dividing with ten or powers of tens.

Q5. What is meant by vernier constant?

Ans: Least count (LC)/Vernier constant:

The difference between one small division on main scale division and one vernier scale division is 0.1 mm. It is called least count (LC) of the Vernier Callipers. Least count of the Vernier Callipers can also be found as given below:

$$Least\ count\ of\ Vernier\ Callipers = \frac{smallest\ reading\ on\ main\ scale}{number\ of\ divisions\ on\ vernier\ scale} = \frac{1\ mm}{10\ division} = 0.1\ mm$$

Hence $$LC = 0.1\ mm = 0.01\ cm$$

Q6. Why is the use of zero error necessary in a measuring instrument?

Ans: When making some kind of scientific measurement, it is necessary to first check your measuring instrument for 'zero error'. The zero error is the reading displayed when you *know* the true reading should be exactly zero.

For example, using a set of vernier calipers, the zero error is the reading that shows when the calipers are fully closed.

As long as you check for zero error, you can then use it to correct your readings.

Positive zero error:

Zero error will be positive if zero line of vernier scale is on the right side of the zero of the main scale. To get the correct value zero error must be recorded and subtracted from each reading.

Negative zero error:

Zero error will be negative if zero line of vernier scale is on the left side of zero of the main scale.

To get the correct value zero error must be recorded and add to each reading.

Q7. Which one of the two instruments is more precise and why?

(a) Vernier Callipers (b) Screw Gauge

Ans: The least count of vernier callipers is 0.01cm while the least count of screw gauge is 0.001 cm.

The vernier callipers measure the length with an accuracy of 0.01 cm. The screw gauge measure the length with an accuracy of 0.001 cm. therefore screw gauge is more precise instrument.

Q8. Illustrate multiples and sub-multiples of length.

Ans: Multiples and sub-multiples of length:

1 km	10^3m
1 cm	10^{-2}m
1 mm	10^{-3}m
1 μm	10^{-6}m
1 nm	10^{-9}m

UNIT 2: KINEMATICS

All theory topics 2.1- 2.7 and examples 2.1-2.7, 2.10 are included.

NOTE:

- All mini exercises, quick quiz and side information are excluded.
- Only topic based related MCQs, Short and Long Questions and numerical are included.

GUESS PAPER & MODEL PAPER # 2
BASED ON UNIT # 2 (Reduced Syllabus)
KINEMATICS

SECTION-A

Time allowed: 20 Minutes **Marks: 12**

Note: Section-A is compulsory. All parts of this section are to be answered on the question paper itself. It should be completed in the first 20 minutes and handed over to the Centre Superintendent. Deleting/overwriting is not allowed. Do not use lead pencil.

Q.1 Encircle the correct option i.e. A / B / C / D. All parts carry equal marks.

i. A body has translatory motion if it moves along a

A. straight line B. circle C. line without rotation D. curved path

ii. The motion of a body about an axis is called

A. circular motion B. rotatory motion
C. vibratory motion D random motion

iii. Which of the following is a vector quantity?

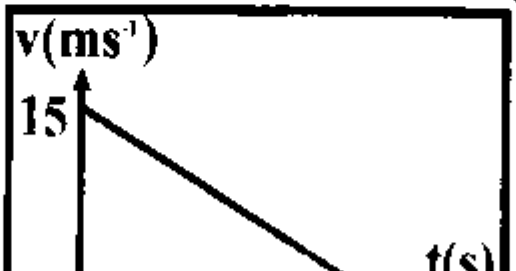
A. speed B. distance C. displacement D. power

iv. A straight line parallel to time-axis on a distance-time graph tells that the object is

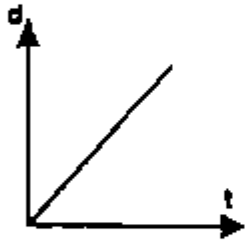
A. moving with constant speed B. at rest
C. moving with variable speed D. in motion

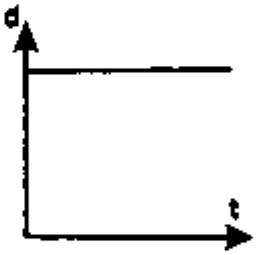
v. The speed-time graph of a car is shown in the figure, which of the following statement is true?

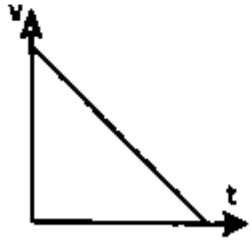
A. car has an acceleration of 1.5 ms^{-2} B. car has constant speed of 7.5 ms^{-1}
C. distance travelled by the car is 75 m D. average speed of the car is 15 ms^{-1}

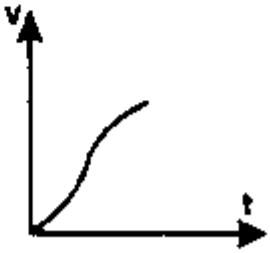


vi. If an object is moving with constant speed then its distance-time graph will be a straight line.
A. along time-axis B. along distance-axis
C. parallel to time-axis D. inclined to time-axis

vii. Which one of the following graphs is representing uniform acceleration?
A.


B.


C.


D.


viii. By dividing displacement of a moving body with time, we obtain
A. speed B. acceleration C. velocity D. deceleration

ix. A ball is thrown vertically upward. Its velocity at the highest point is:
A. $-10\ ms^{-1}$ B. zero C. $10\ ms^{-2}$ D. none of these

x. A change in position is called:
A. speed B. velocity C. displacement D. distance

xi. A train is moving at a speed of 36 kmh^{-1}. Its speed expressed in ms^{-1} is:
A. $10\ ms^{-1}$ B. $20\ ms^{-1}$ C. $25\ ms^{-1}$ D. $30\ ms^{-1}$

xii. A car starts from rest. It acquires a speed of 25 ms^{-1} after 20 s. The distance moved by the car during this time is:
A. 31.25 m B. 250 m C. 500 m D. 5000 m

Time Allowed: 2:40 Minutes Total Marks: 53

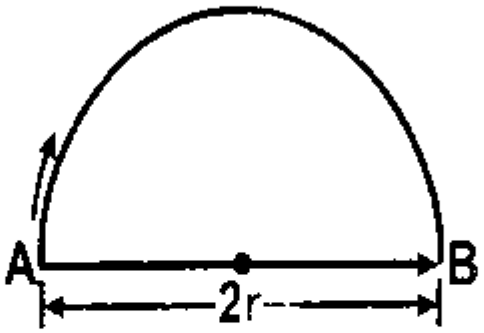
Note: Answer any six parts from Section 'B' and attempt any five parts from Section-C. Attempt any two questions from Section 'D' on the separately provided answer book. Use supplementary answer sheet i.e. Sheet–B if required. Write your answers neatly and legibly

SECTION – B (Marks 18)

Q.2 Attempt any SIX parts from the following. All parts carry equal marks. (6 x 3 = 18)

(i) Why vector quantities cannot be added and subtracted like scalar quantities?
(ii) Can a body moving at a constant speed have acceleration?
(iii) Which of the following can be obtained from speed - time graph of a body?
(i) Initial speed. (ii) Final speed.
(iii) Distance covered in time t. (iv) Acceleration of motion.
(iv) Define the term position?
(v) Sketch a distance-time graph for a body at rest. How will you determine the speed of a body from this graph?
(vi) Prove that $S = v_i t + \frac{1}{2}at^2$

(viii) A cyclist completes half round of a circular track of radius 318 m in 1.5 minutes. Find its speed and velocity.



SECTION – C (Marks 15)

Q.3 Attempt any FIVE parts from the following. All parts carry equal marks. (5 × 3 = 15)

(i) Differentiate between positive and negative acceleration?

(ii) A car has a velocity of 10 ms^{-1}. It accelerates at 0.2 ms^{-2} for half minute. Find the distance travelled during this time and the final velocity of the car.

(iii) How do riders in a Ferris wheel possess translatory motion but not circular motion?

(iv) Describe translatory motion with the help of examples?

(v) What is the purpose of distance-time graph? How it is plotted?

(vi) A train moves with a uniform velocity of 36 kmh^{-1} for 10 s. Find the distance travelled by it.

(vii) A train starts from rest with an acceleration of 0.5 ms^{-2}. Find its speed in kmh^{1}, when it has moved through 100 m.

SECTION – D (Marks 20)

Note: Attempt any TWO questions. All questions carry equal marks. (2 × 10 = 20)

Q.4 (a) Differentiate between the following:

(i) Rest and motion. (ii) Circular motion and rotator motion

(iii) Distance and displacement (iv) Speed and velocity

(v) Linear and random motion (vi) Scalars and vectors

(b) A cricket ball is hit vertically upwards and returns to ground 6 s later. Calculate

(i) maximum height reached by the ball.

(ii) initial velocity of the ball.

Q.5 (a) A tennis ball is hit vertically upward with a velocity of 30 ms^{-1}. It takes 3 s to reach the highest point. Calculate the maximum height reached by the ball. How long it will take to return to ground?

(b) Prove that $2aS = v_f^2 - v_i^2$

Q.6 (a) How can vector quantities be represented graphically?

(b) A train starts from rest. It moves through 1 km in 100 s with uniform acceleration. What will be its speed at the end of 100 s.

SOLUTION OF GUESS PAPER & MODEL PAPER # 2
(Reduced Syllabus)

SECTION- A (MCQs)

i. A	ii. B	iii. C	iv. B	v. A	vi. D

SECTION – B (Marks 18)

Q.2 Attempt any SIX parts from the following. All parts carry equal marks. (6 × 3 = 18)

(i) Why vector quantities cannot be added and subtracted like scalar quantities?

Ans: The scalar quantities obey the rules of arithmetic and ordinary algebra because scalar quantities have no direction. Since vectors have magnitude as well as direction, so vectors obey the special rules of vector algebra therefore vectors are added by head to tail rule (Vector algebra).

(ii) Can a body moving at a constant speed have acceleration?

Ans: Yes, when a body is moving with constant speed, the body can have acceleration if its direction changes. For example, if the body is moving along a circle with constant speed, it will have acceleration due to the change of direction at every instant.

(iii) Which of the following can be obtained from speed - time graph of a body?

(i) Initial speed. **(ii) Final speed.**
(iii) Distance covered in time *t*. **(iv) Acceleration of motion.**

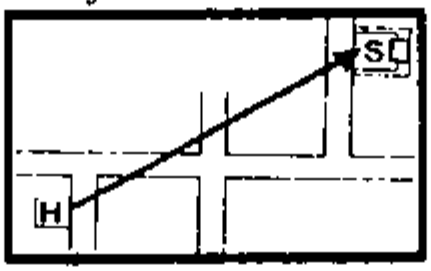
Ans: All the given above factors can be obtained from speed-time graph.

(iv) Define the term position?

Ans: Position:

The term position describes the location of a place or a point with respect to some reference point called origin.

For example: You want to describe the position of your school from your home. Let the school be represented by S and home by H. The position of your school from your home will be represented by a straight line HS in the direction from H to S.

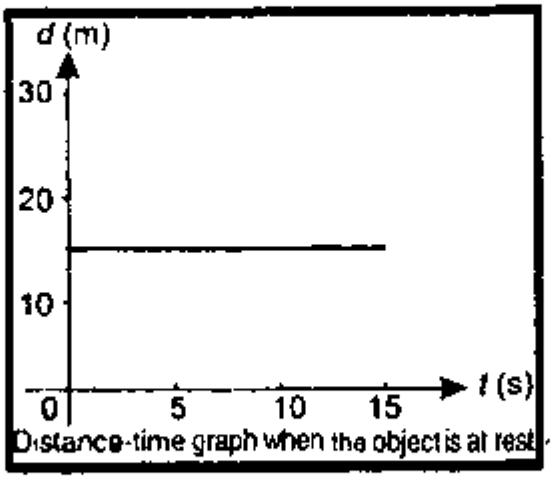


Position of the school S from the home H.

(v) Sketch a distance-time graph for a body at rest. How will you determine the speed of a body from this graph?

Ans: Object at rest:

In the graph shown in figure, the distance moved by the object with time is zero. That is, the object is at rest. Thus a horizontal line parallel to time axis on a distance-time graph shows that speed of the object is zero.



Distance-time graph when the object is at rest

(vi) Prove that $S = v_i t + \frac{1}{2}at^2$

$S = \left(\frac{V_f + V_i}{2}\right) \times t$ .....(i)

From first equation of motion. $v_f = v_i + at$

Putting the value of v_f in equation (i).

$$S = \left(\frac{V_i + at + V_i}{2}\right) \times t \quad = \left(\frac{2V_i + at}{2}\right) \times t \quad = \frac{2V_i t + at^2}{2}$$

$$S = \frac{2V_i t}{2} + \frac{at^2}{2}$$

$$S = V_i t + \frac{1}{2}at^2$$

(vii) Find the retardation produced when a car moving at a velocity of 30 ms^{-1} slows down uniformly to 15 ms^{-1} in 5 s.

Solution: Initial velocity = $V_i = 30\ ms^{-1}$

Final velocity = $V_f = 15\ ms^{-1}$

Time = $t = 5\ s$

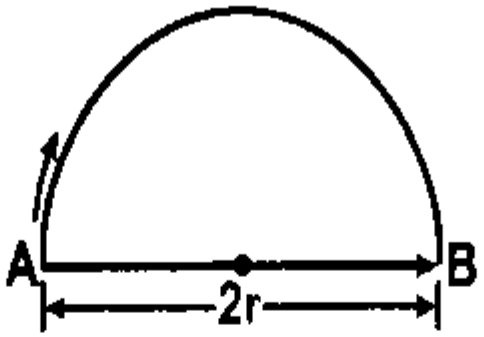
Retardation = $a = ?$

As $\text{Acceleration} = \frac{\text{change in velocity}}{\text{time interval}} = \frac{V_f - V_i}{t}$

or $a = \frac{15\ ms^{-1} - 30\ ms^{-1}}{5\ s} = \frac{-15\ ms^{-1}}{5\ s} = -3\ ms^{-2}$

Since negative acceleration is called as deceleration / retardation. Thus deceleration of the car is 3 ms^{-2}.

(viii) A cyclist completes half round of a circular track of radius 318 m in 1.5 minutes. Find its speed and velocity.



Solution: Radius of track = $r = 318\ m$

Time taken = $t = 1\ min\ .\ 30\ s = 60 + 30 = 90\ s$

Distance covered in half round = $\pi \times$ radius = $3.14 \times 318\ m = 999\ m$

Displacement = $2r = 2 \times 318\ m = 636\ m$

$$\text{Speed} = \frac{\text{distance}}{\text{time}} = \frac{999\ m}{90\ s} = 11.1\ ms^{-1}$$

$$\text{velocity} = \frac{\text{displacement}}{\text{time taken}} = \frac{636\ m}{90\ s} = 7.07\ ms^{-1}$$

Thus speed of the cyclist is 11.1 ms^{-1} along the track and its velocity is about 7.1 ms^{-1} along the diameter of the track.

SECTION – C (Marks 15)

Q.3 Attempt any FIVE parts from the following. All parts carry equal marks. (5 × 3 = 15)

Negative acceleration/Deceleration or retardation:

Acceleration of a body is negative if velocity of the body decreases. The direction of negative acceleration is opposite to the direction in which the body is moving. Negative acceleration is also called deceleration or retardation.

(ii) A car has a velocity of 10 ms^{-1}. It accelerates at 0.2 ms^{-2} for half minute. Find the distance travelled during this time and the final velocity of the car.

Solution: Initial velocity = $v_i = 10ms^{-1}$ Acceleration $a = 0.2ms^{-2}$

Time $t = 0.5min. = 0.5 \times 60 = 30\ s$

(a) Distance S = ? (b) Final velocity v_f = ?

$S = vit + \frac{1}{2}at^2 \Rightarrow S = 10 \times 30 + \frac{1}{2} \times 0.2 \times (30)^2 \Rightarrow S = 300 + \frac{1}{2} \times \frac{2}{10} \times 900$

$S = 300 + 90 \Rightarrow S = 390\ m$

Using 1st equation of motion

$v_f = v_i + at \Rightarrow v_f = 10 + 0.2 \times 30 \Rightarrow v_f = 10 + 6 \Rightarrow v_f = 16\ ms^{-1}$

(iii) How do riders in a Ferris wheel possess translatory motion but not circular motion?

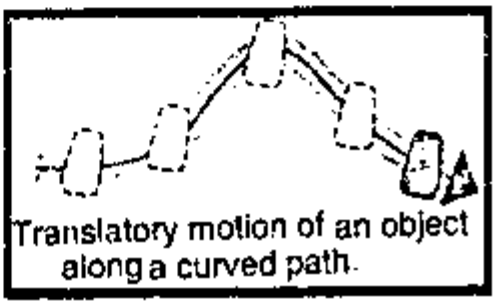
Ans: Riders in a Ferris wheel possess translatory motion because their motion is in a circle without rotation

(iv) Describe translatory motion with the help of examples?

Ans: Translatory motion:

In translational motion, a body moves along a line without any rotation. The line may be straight or curved

Examples: Riders moving in a Ferris wheel are also in translational motion. Their motion is in a circle without rotation.



Translatory motion of an object along a curved path.

(v) What is the purpose of distance-time graph? How it is plotted?

Ans: Distance-time graph:

It is useful to represent the motion of objects using graphs. The terms distance and displacement are used interchangeably when the motion is in a straight line. Similarly if the motion is in a straight line then speed and velocity are also used interchangeably.

Note: In a distance-time graph, time is taken along horizontal axis while vertical axis shows the distance covered by the object.

(vi) A train moves with a uniform velocity of 36 kmh^{-1} for 10 s. Find the distance travelled by it.

Solution: Velocity = $v = 36kmh^{-1} = \frac{36 \times 1000}{60 \times 60\ s} = \frac{36000}{3600} = 10ms^{-1}$

Time t = 10s

Distance = S = ?

$S = vt$

$S = 10 \times 10 = 100m$

(vii) A train starts from rest with an acceleration of 0.5 ms^{-2}. Find its speed in kmh^{1}, when it has moved through 100 m.

Solution: Initial velocity $v_i = 0\ ms^{-1} \Rightarrow$ Acceleration $a = 0.5\ ms^{-2}$

Distance S = 100 m $\Rightarrow$ Final velocity v_f = ?

$2aS = v_f^2 - v_i^2 \Rightarrow 2 \times 0.5 \times 100 = v_f^2 - 0$

or $100 = v_f^2 \Rightarrow$ or $v_f^2 = 100$

$\Rightarrow v_f = 10ms^{-1}$ ..... (i)

Speed in kmh^{-1}:

SECTION – B (Marks 20)

Note: Attempt any TWO questions. All questions carry equal marks. (2 × 10 = 20)

Q.4 (a) Differentiate between the following:

(i) Rest and motion. (ii) Circular motion and rotator motion
(iii) Distance and displacement (iv) Speed and velocity
(v) Linear and random motion (vi) Scalars and vectors

Ans: (i) Rest and motion.

Difference between rest and motion:

Rest: A body is said to be at rest, if it does not change its position with respect to its surroundings.

Motion: A body is said to be in motion, if it changes its position with respect to its surroundings.

The state of rest or motion of a body is relative. For example, a passenger sitting in a moving bus is at rest because he/she is not changing his/her position with respect to other passengers or objects in the bus But to an observer outside the bus, the passengers and the objects inside the bus are in motion.

(ii) Difference between circular and rotatory motion:

Any turning as if on an axis is rotary motion. Any rotary motion where the radius of gyration length and axis of rotation are fixed is circular motion.

And that's the difference. Circular motion is just a special case of rotary motion. That is, there is no fixed axis and radius restriction for rotary motion, but there is for circular motion.

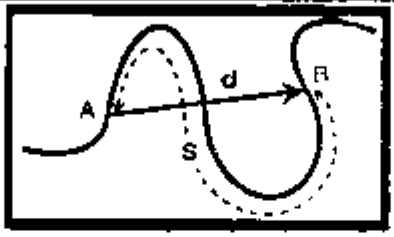
For example, all planets have rotary motion around their suns But most of the orbits are elliptical; so the rotation axes (there are two in an ellipse) and radii of gyration vary as they trek around. So most, if not all, planets do not have circular motion.

Note: Gyration length:

A length that represents the distance in a rotating system between the point about which it is rotating and the point to or from which a transfer of energy has the maximum effect.

(iii) Difference between distance and displacement:

Distance	Displacement
i. Length of a path between two points is called the distance between those points.	**i.** Displacement is the shortest distance between two points which has magnitude and direction
ii. Distance is a scalar quantity.	**ii.** Displacement is a vector quantity.
iii. Distance is denoted by "S". $S = vt$ Its SI unit is metre (m)	**iii.** Displacement is denoted by "d". $d = vt$ Its SI unit is metre (m).



Distance S (dotted line) and displacement d (dark line) from points A to B.

(iv) Difference between speed and velocity:

Speed	Velocity
i. The distance covered an object in unit time is by called its speed. $Speed = \frac{distance\ covered}{time\ taken}$ $Distance = speed \times time$ or $S = vt$	**i.** The rate of displacement of a body is called its velocity $Velocity = \frac{displacement}{time\ taken}$ $v = \frac{d}{t}$ or $d = vt$

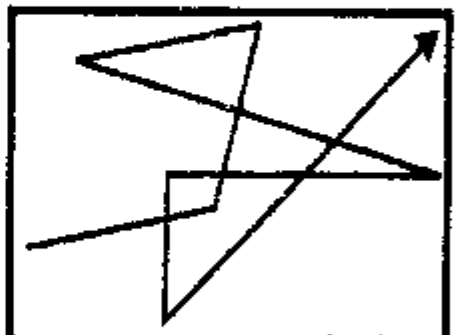
(v) Difference between Linear and random motion.

i. Linear motion: Straight line motion of a body is knows as its linear motion.

Examples: The motion of objects such as a car moving on a straight and level road is linear motion. Aeroplanes flying straight in air and objects falling vertically down are also the examples of linear motion

iii. Random motion: The disordered or irregular motion of an object is called random motion.

Examples: The motion of insects and birds are irregular.
Thus, motion of insects and birds is random motion.
The motion of dust or smoke particles in the air is also random motion.
The Brownian motion of a gas or liquid molecules along a zig-zag path is also an example of random motion.


Random motion of gas molecules is called Brownian motion

(vi) Difference between Scalars and vectors:

Scalars	Vectors
A scalar quantity is described completely by its magnitude only	A vector quantity is described completely by magnitude and direction.
Examples: Examples of scalars are mass, length, time, speed, volume, work, energy, density, power, electric charge, pressure, area, temperature,	**Examples:** Examples of vectors are velocity, displacement, force, momentum, torque, weight, electric potential, etc.

(b) A cricket ball is hit vertically upwards and returns to ground 6 s later. Calculate
(i) maximum height reached by the ball,
(ii) initial velocity of the ball.

Solution: Acceleration due to gravity = g = -10 ms^{-2} (for upward motion)

Time to reach maximum height (one sided time) = $t = \frac{6}{2} = 3$ s

Velocity at maximum height = $v_f = 0$ ms^{-1}

(i) Maximum height reached by the ball S = h = ?

(ii) Maximum initial velocity of the ball v_i = ?

Since, $v_f = v_i + gt \Rightarrow 0 = v_i - (-10) \times 3 \Rightarrow v_i = 30$ ms^{-1}

(ii) Now using 3rd equation of motion

$2aS = v_f^2 - v_i^2$

$S = \frac{v_f^2 - v_i^2}{2g} \Rightarrow S = \frac{(0)^2 - (30)^2}{2 \times (-10)} \Rightarrow S = \frac{900}{20}$ S = 45 m

Q.5 (a) A tennis ball is hit vertically upward with a velocity of 30 ms^{-1}. It takes 3 s to reach the highest point. Calculate the maximum height reached by the ball. How long it will take to return to ground?

Solution: Initial velocity = $v_i = 30$ ms^{-1}
Acceleration due to gravity g = -10 ms^{-2}
Time to reach maximum height = t = 3 s
Final velocity = $v_f = 0$ ms^{-1}

(i) Maximum height attained by the ball S = ?

(ii) Time taken to return to ground t = ?

$S = vit + \frac{1}{2}gt^2$

Total time = Time to reach maximum height + Time to return to the ground = 3s + 3s = 6s

(b) Prove that $2aS = v_f^2 - v_i^2$

Ans: See Page # 95, Q3. (b) From FBISE Past Paper (2016).

Q.6 (a) How can vector quantities be represented graphically?

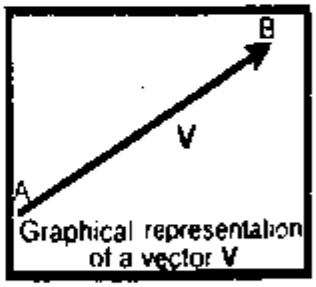
Ans: Representation of vectors (Symbolic representation of a vector):

To differentiate a vector from a scalar quantity, we generally use bold letters to represent vector quantities, such as **F**, **a**, **d** or a bar or arrow over their symbols such as $\bar{F}$, $\bar{a}$, $\bar{d}$ or $\vec{F}$, $\vec{a}$ and $\vec{d}$.

Vector representation:

Graphical representation of a vector:

A straight line is drawn with an arrow head at one end. The length of the line, according to some suitable scale, represents the magnitude and the arrow head gives the direction of the vector.



Graphical representation of a vector V

(b) A train starts from rest. It moves through 1 km in 100 s with uniform acceleration. What will be its speed at the end of 100 s.

Solution: Initial velocity $v_i = 0\ ms^{-1}$; Distance S = 1km = 1000 m ; Time t = 100 s

Final velocity $v_f = ?$ $\Rightarrow$ $S = v_i t + \frac{1}{2} at^2$

$1000 = 0 \times 100 + \frac{1}{2} \times a \times (100)^2$ $\Rightarrow$ $1000 = \frac{1}{2} \times 10000a$

$1000 = 5000a$ $\Rightarrow$ $a = \frac{1000}{5000} = 0.2\ ms^{-2}$

Now using 1st equation of motion

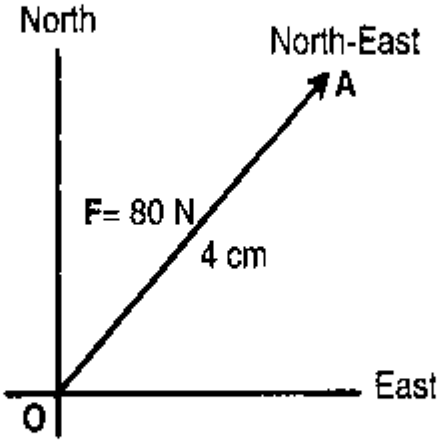
$v_f = v_i + at$ $\Rightarrow$ $v_f = 0 + 0.2 \times 100$ $\Rightarrow$ $v_f = 20\ ms^{-1}$

INCLUDED IMPORTANT EXAMPLES

EXAMPLE 2.1: Represent a force of 80 N acting toward North of East.

Solution:

Step 1: Draw two lines perpendicular to each other. Horizontal line represents East-West and vertical line represents North-South direction as shown in figure.



Representing 80 N force acting North-East.

Step 2: Select a suitable **scale** to represent the given vector. In this case we may take a **scale** which

Step 4: Put an arrow head at the end of the line. In this case arrow head is at point A. Thus, the line OA will represent a vector i.e., the force of 80 N acting towards North-East.

EXAMPLE 2.2: **A sprinter completes its 100 metre race in 12 s. Find its average speed.**

Solution: Total distance = 100 m ; Total time taken = 12 s

$$\text{Average speed} = \frac{\text{Total distance moved}}{\text{Total time taken}} = \frac{100\ \text{m}}{12\ \text{s}} = 8.33\ \text{ms}^{-1}$$

Thus the speed of the sprinter is $8.33\ \text{ms}^{-1}$.

EXAMPLE 2.4: **A car starts from rest. Its velocity becomes $20\ \text{ms}^{-1}$ in 8 s. Find its acceleration.**

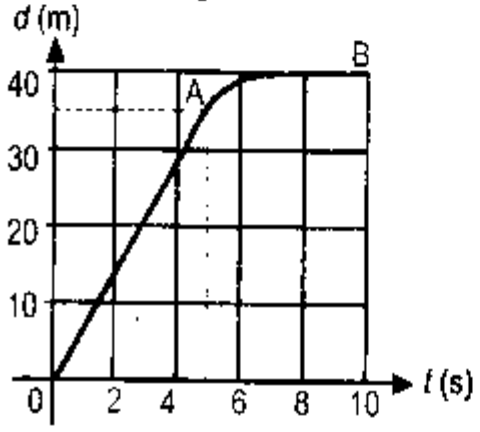
Solution: Initial velocity = $V_i = 0\ \text{ms}^{-1}$; Final velocity = $V_f = 20\ \text{ms}^{-1}$

Time taken = $t = 8\ s$; Acceleration = $a = ?$

As $$a = \frac{V_f - V_i}{t} = \frac{20\ \text{ms}^{-1} - 0\ \text{ms}^{-1}}{8\ \text{s}} = \frac{20\ \text{ms}^{-1}}{8\ \text{s}} = 2.5\ \text{ms}^{-2}$$

Thus, the acceleration of the car is $2.5\ \text{ms}^{-2}$.

EXAMPLE 2.6: **Figure 2.21 shows the distance-time graph of a moving car.**



Distance-time graph of a car

From the graph, find

(a) **the distance car has traveled.**

(b) **the speed during the first five seconds.**

(c) **average speed of the car.**

(d) **speed during the last 5 seconds.**

Solution: **(a)** Total distance travelled = 40 m

(b) Distance travelled during first 5 s is 35 m

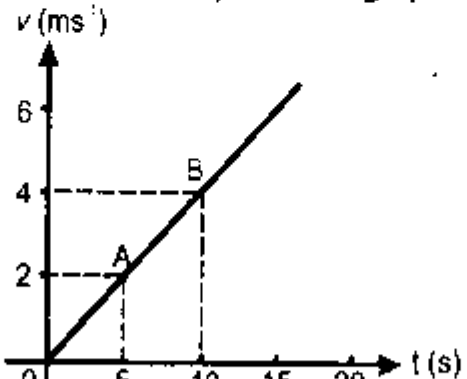
$$\text{Speed} = \frac{\text{Total distance moved}}{\text{Total time taken}} = \frac{35\ \text{m}}{5\ s} = 7\ \text{ms}^{-1}$$

(c) $$\text{Average speed} = \frac{40\ \text{m}}{10\ \text{s}} = 4\ \text{ms}^{-1}$$

(d) Distance moved during the last 5 s = 5 m

$$\text{Speed} = \frac{\text{Total distance moved}}{\text{Total time taken}} = \frac{5\ \text{m}}{5\ s} = 1\ \text{ms}^{-1}$$

EXAMPLE 2.7: **Find the acceleration from speed-time graph shown in figure.**



Solution: On the graph in the figure, point A gives speed of the object as $2\ ms^{-1}$ after 5 s and point B gives speed of the object as $4\ ms^{-1}$ after 10 s.

As $\text{acceleration} = \text{slope of AB}$

$$\text{slope} = m = \frac{\text{rise (y-coordinate)}}{\text{run (x-coordinate)}}$$

Where, $$\text{slope} = \frac{\text{change in velocity}}{\text{time interval}}$$

$$\text{Acceleration} = \frac{\text{change in velocity}}{\text{time taken}} = \frac{\Delta V}{\Delta t}$$

$$\therefore \quad \text{Acceleration} = \frac{4\ ms^{-1} - 2\ ms^{-1}}{10\ s - 5\ s} = \frac{2\ ms^{-1}}{5\ s} = 0.4\ ms^{-2}$$

Speed-time graph in the figure gives acceleration of the object as $0.4\ ms^{-2}$.

EXAMPLE 2.10: **A car travelling at $10\ ms^{-1}$ accelerates uniformly at $2\ ms^{-2}$. Calculate its velocity after 5 s.**

Solution: Initial velocity $= V_i = 10\ ms^{-1}$; Acceleration $= a = 2\ ms^{-2}$

Time taken $= t = 5\ s$; Final velocity $= V_f = ?$

Using the first equation of motion, we get

$$V_f = V_i + at$$

$$V_f = 10\ ms^{-1} + 2\ ms^{-2} \times 5\ s \quad ; \quad V_f = 20\ ms^{-1}$$

The velocity of the car after 5 s is $20\ ms^{-1}$.

IMPORTANT QUESTIONS

Q1. Define the terms speed, velocity, and acceleration.

Ans: Speed: The distance covered an object in unit time is by called its speed.

$$Speed = \frac{distance\ covered}{time\ taken} \quad \Rightarrow \quad v = \frac{s}{t}$$

Velocity: The rate of displacement of a body is called its velocity.

$$Velocity = \frac{displacement}{time\ taken} \quad \Rightarrow \quad v = \frac{d}{t}$$

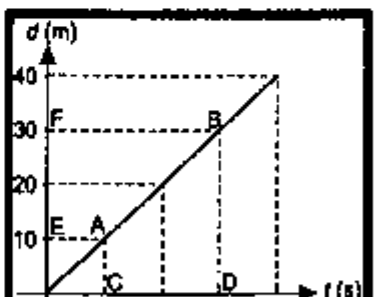
Acceleration: Acceleration is defined as the rate of change of velocity of a body.

$$Acceleration = \frac{change\ in\ velocity}{time\ taken}$$

$$Acceleration = \frac{final\ velocity - initial\ velocity}{time\ taken} \quad \Rightarrow \quad a = \frac{v_f - v_i}{t}$$

Unit of acceleration: SI unit of acceleration is metre per second per second (ms^{-2}).

Q2. Sketch a distance-time graph for a body starting from rest. How will you determine the speed of a body from this graph?



Ans: Distance-time graph for a body starting from rest:

When a body starting from rest then the distance-time graph is a straight line. Its slope gives the speed of the object.

Speed of a body from graph: Consider two points A and B on the graph.

$$\text{speed of the object} = \text{Slope of line AB}$$

$$= \frac{\text{distance EF}}{\text{time CD}} = \frac{20\ m}{10\ s} = 2\ ms^{-1}$$

Q3. What would be the shape of a speed - time graph of a body moving with variable speed?

Ans: Object moving with variable speed:

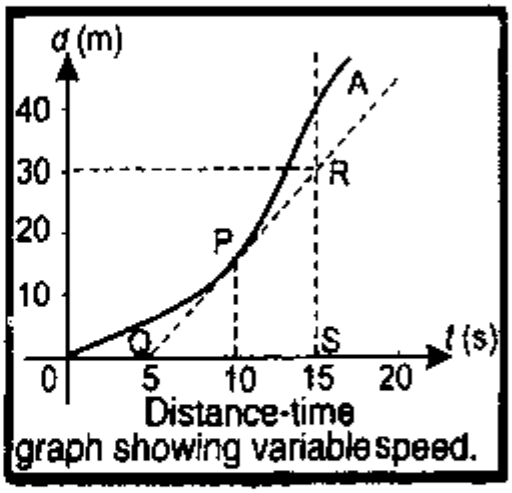
When an object does not cover equal distances in equal intervals of time then its speed is not constant. In this case the distance-time graph is not a straight line.

The slope of the curve at any point can be found from the slope of the tangent at that point.

For example,

$$Slope\ of\ tangent\ at\ P = \frac{RS}{QS} = \frac{30\ m}{10\ s} = 3\ ms^{-1}$$

Thus, speed of the object at P is $3\ ms^{-1}$.



Distance-time graph showing variable speed.

Note: The speed is higher at instants when slope is greater; speed is zero at instants when slope is horizontal.

Q4. Sketch a velocity - time graph for the motion of the body. From the graph explaining each step, calculate total distance covered by the body.

Ans: Velocity-time Graph:

Calculation of Distance moved by an object from velocity time graph:

The distance moved by an object can also be determined by using its velocity-time graph.

(a) If object moves at constant velocity v for time t. The distance covered by the object. is v × t. This distance can also be found by calculating the area under the velocity-time graph. This area is shaded and is equal to **v × t.**

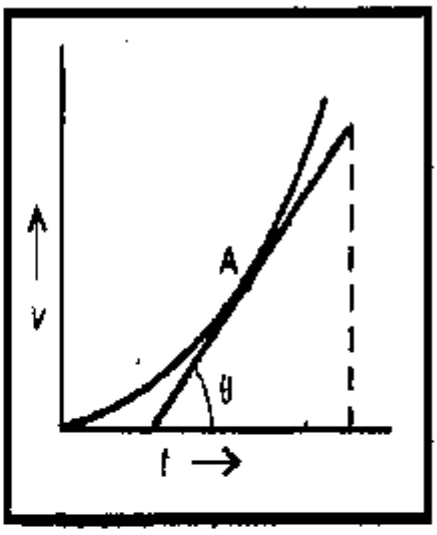
(b) If the velocity of the object increases uniformly from 0 to v in time t. The magnitude of its average velocity is given by

$$V_{av} = \frac{0 + v}{2} = \frac{1}{2} v$$

Distance covered = average velocity × time = $\frac{1}{2}$ v × t

Now we calculate the area under velocity-time graph which is equal to the area of the triangle shaded in Figure.

Its value is equal to **1/2 base × height = 1/2 v × t**



Note: The area between the velocity-time graph and the time axis is numerically equal to the distance covered by the object.

UNIT 3: DYNAMICS

3.1: Force, Inertia and Momentum
3.2: Newton's Laws of Motion (1st 2nd 3rd, mass and weight, Force and Momentum, Law of Conservation of momentum)
3.3: Friction (Rolling Friction, Advantages / disadvantages of Friction, methods to reduce friction only)
3.4: Uniform circular motion (Centripetal force and centrifugal force only)

NOTE:

- All mini exercises, quick quiz and side information are excluded.
- Only topic based related MCQs, Short and Long Questions and numerical are included.

GUESS PAPER & MODEL PAPER # 3
BASED ON UNIT # 3 (Reduced Syllabus)
DYNAMICS

SECTION-A

Time allowed: 20 Minutes **Marks: 12**

Note: Section-A is compulsory. All parts of this section are to be answered on the question paper itself. It should be completed in the first 20 minutes and handed over to the Centre Superintendent. Deleting/overwriting is not allowed. Do not use lead pencil.

Q.1 Encircle the correct option i.e. A / B / C / D. All parts carry equal marks.

i. Newton's first law of motion is valid only in the absence of:
A. force B. net force C. friction D. momentum

ii. Inertia depends upon
A force B. net force C. mass D. velocity

iii. A boy jumps out of a moving bus. There is a danger for him to fall:
A towards the moving bus B away from the bus
C. in the direction of motion D opposite to the direction of motion

iv. A cyclist of mass 30 kg exerts a force of 250 N to move his cycle. The acceleration is $4ms^{-2}$. The force of friction between the road and tires will be
A. 130 N B. 120 N C. 110 N D. 115 N

v. The mass of a body:
A. decreases when accelerated B increases when accelerated
C. decreases when moving with high velocity D. none of the above

vi. Two bodies of masses m_1 and m_2 attached to the ends of an inextensible string passing over a frictionless pulling such that both move vertically. The acceleration of the bodies is:
A. $\frac{m_1 \times m_2}{\quad} g$ B. $\frac{m_1 - m_2}{\quad} g$ C. $\frac{m_1 + m_2}{\quad} g$ D. $\frac{2m_1 m_2}{\quad} g$

viii. When horse pulls a cart, the action is on the:
A. cart B. Earth C. horse D. Earth and cart

ix. Which of the following material lowers friction when pushed between metal plates?
A. water B. fine marble powder C. air D. oil

x. A force of 20 N moves a body with an acceleration of 2 ms^{-2}. What is its mass?
A. 20 kg B. 5 kg C. 10 kg D. 15 kg

xi. The weight of a body is 147 N. What is its mass? (Take the value of g as 10 ms^{-2})
A. 14 kg B. 12 kg C. 15 kg D. 14 .7 kg

xii. How much time is required to change 22 Ns momentum by a force of 20 N?
A. 1.2 s B. 1.3 s C. 1.1 s D. 1.4 s

Time Allowed: 2:40 Minutes **Total Marks: 53**

Note: Answer any six parts from Section 'B' and attempt any five parts from Section-C. Attempt any two questions from Section 'D' on the separately provided answer book. Use supplementary answer sheet i.e. Sheet–B if required. Write your answers neatly and legibly

SECTION – B (Marks 18)

Q.2 Attempt any SIX parts from the following. All parts carry equal marks. (6 × 3 = 18)

(i) Why is it dangerous to travel on the roof of a bus?

(ii) A bullet has a very small inertia due to its small mass. But why does its impact is so strong when it is fired from the gun?

(iii) Why the passengers standing in a bus fall forward when its driver applies brakes suddenly?

(Iv) Show that Ns = Kg m/s OR Ns = Kg ms^{-1}

(v) Action and reaction are always equal and opposite. Then how does a body moves?

(vi) A force of 20 N moves a body with an acceleration of 2 ms^{-2}. What is its mass?

(vii) What is difference between mass and weight?

(viii) Why does a passenger move outward when a bus takes a turn?

SECTION – C (Marks 15)

Q.3 Attempt any FIVE parts from the following. All parts carry equal marks. (5 × 3 = 15)

(i) What is difference between Sliding friction and rolling friction?

(ii) A horse pushes the cart. If the action and reaction are equal and opposite then how does the cart move?

(iii) A body has weight 20 N. How much force is required to move it vertically upwards with an acceleration of 2 ms^{-2} ?

(iv) What is centrifugal force? Explain.

(v) What are the disadvantages of the friction?

(vi) How does oiling the moving parts of a machine lowers friction?

(vii) Find the acceleration produced by a force of 100 N in a mass of 50 kg.

SECTION – D (Marks 20)

Note: Attempt any TWO questions. All questions carry equal marks. (2 × 10 = 20)

Q.4 (a) State and prove Newton's second law of motion and show that F = ma.

(b) How much force is needed to prevent a body of mass 10 kg from falling?

Q.5 (a) Law of conservation of momentum.

(b) How much centripetal force is needed to make a body of mass 0.5 kg to move in a circle of radius 50 cm with a speed 3 ms^{-1}?

Q.6 (a) How can you relate a force with the change of momentum of a body? And what is

SOLUTION OF GUESS PAPER & MODEL PAPER # 3
(Reduced Syllabus)

SECTION- A (MCQs)

i. B	ii. C	iii. C	iv. A	v. D	vi. B
vii. C	viii. D	ix. D	x. C	xi. D	xii. D

SECTION – B (Marks 18)

Q.2 Attempt any SIX parts from the following. All parts carry equal marks. **(6 × 3 = 18)**

(i) Why is it dangerous to travel on the roof of a bus?

Ans: Because the friction force due air acting on the upper part of body the person who travelling on the roof of the running bus try to turn over which is dangerous for passenger while the lower portion remain at rest w.r.t. the roof of the bus due to inertia.

(ii) A bullet has a very small inertia due to its small mass. But why does its impact is so strong when it is fired from the gun?

Ans: According to the law of conservation of momentum mass of bullet is much smaller than the gun therefore the recoil is much greater than the velocity of gun Therefore the impact of bullet is very strong.

(iii) Why the passengers standing in a bus fall forward when its driver applies brakes suddenly?

Ans: The passengers standing in a bus fall forward when its driver applies brakes suddenly. It is because the upper parts of their bodies tend to continue their motion, while lower parts of their bodies in contact with the bus stop with it. Hence, they fall forward.

(iv) Show that Ns = Kg m/s OR Ns = Kg ms^{-1}

Ans: L.H.S = Ns = $(1kg \times 1ms^{-2}) \times s$ = $Kg \times ms^{-2+1}$ = $Kg \times ms^{-1}$ = Kg m/s

(v) Action and reaction are always equal and opposite. Then how does a body moves?

Ans: Actions and reactions (forces acting on an object) are equal and opposite when the object is at equilibrium. When we apply external force to pull, push and twist, the equilibrium is disturbed means, now the magnitude of action (force provided by you) and reaction (force provided by the objects) is not equal. That is why it is possible to twist, pull, move and push the object in the direction of applied force.

(vi) A force of 20 N moves a body with an acceleration of 2 ms^{-2}. What is its mass?

Solution: Force = F = 20 N

Acceleration = a = 2 ms^{-2} $\Rightarrow$ Mass = m = ? $\Rightarrow$ F = ma

or $m = \frac{F}{a}$ $\Rightarrow$ $m = \frac{20}{2} = 10$ kg

(vii) What is difference between mass and weight?

Ans: Mass and weight:

Mass	Weight
1. The quantity of matter contained in a body is called its mass	**1.** Weight is the force with which earth attracts a body towards its centre.
2. The mass of a body remains constant everywhere, whether it is measured at a point far away from the centre of the earth, or on the surface at the centre of the earth.	**2.** The weight of a body is not constant quantity but its value is different at different places.
3. Mass is a scalar quantity.	**3.** Weight is a vector quantity and is always directed

6. Mass of the body, [illegible] gr[illegible] the body can be zero. i.e. at the centre of earth and in space where g= 0, So W = mg = m × 0 = 0
7. It is the measure of inertia [illegible] is given by W = mg

(viii) Why does a passenger move [illegible] when a bus takes a turn?

Ans: An inward net force is required [illegible]. This inward net force requirement is known as a centripetal force requirement. [illegible] any net force, an object in motion (such as the passenger) continues in motion in a straight line at constant speed. Due to the absence of necessary centripetal force a passenger moves outward when a bus takes a turn.

SECTION – C (Marks 15)

Q.3 Attempt any FIVE parts from the following. All parts carry equal marks. (5 × 3 = 15)

(i) What is difference between Sliding friction and rolling friction?

Ans: Sliding friction:

A force between the sliding objects which opposes the relative motion between them is called sliding friction.

Rolling friction:

Rolling friction is the force of friction between a rolling body and a surface over which it rolls. Rolling friction is lesser than the sliding friction.

(ii) A horse pushes the cart, [illegible] action are equal and opposite then how does the cart move?

Ans: First of all wh[illegible] an equal but opposite reaction on the horse, the action and reaction. If this was [illegible] horse and cart would indeed remain stationary.

However there is another force [illegible] the horse and the ground. The horse's hooves press down on the ground and the ground pushes back on the horse.

If the reaction force of the gr[illegible] the reaction force of the cart on the horse, then the horse will move forward. The cart will move forward when the force exerted on it by the horse is greater than the frictional force between the cart and the ground.

(iii) A body has weight 20 N. How much force is required to move it vertically upwards with an acceleration of 2 ms^{-2} ?

Solution: Weight = w = 20 N

Acceleration = a = 2 ms^{-2}

Vertically upward force (tension) = T = ?

$F_{net} = T - w$ or $ma = T - mg$ or $ma + mg = T$

or $T = m(a + g)$ ..... (i)

Now, $m = \frac{w}{g} \Rightarrow m = \frac{20}{10} = 2$ kg

Putting the value of m in Eq.(i), we get

$T = 2(2 + 10) = 2(12) \Rightarrow T = 24N$

(iv) What is centrifugal force? Explain.

Ans: Centrifugal force:

The centripetal force pulls the object towards the centre of the circle. As a reaction, another force appears at the centre of the circle which is equal in magnitude to the centripetal force but opposite in direction. This outward reaction is called centrifugal force.

According to Newton's third law of motion, there exists a reaction to this centripetal force. Centripetal reaction that pulls the string outward is sometimes called the centrifugal force.

Example:

(v) What are the disadvantages of the friction?

Ans: Problems caused by friction:

1. It causes energy lost and reduces the efficiency of machines.
2. It causes rapid wear and tear of the moving parts of machines.

Most of our useful energy is lost as heat and sound due to the friction between various moving parts of machines. In machines, friction also causes wear and tear of their moving parts.

(vi) How does oilIny the moving parts of a machine lowers friction?

Ans: The friction can be reduced by lubricating the sliding surfaces.

The oil helps slick (polished) the two surfaces so that the molecular surfaces become easier to slide on with less friction.

(vii) Find the acceleration produced by a force of 100 N in a mass of 50 kg.

Solution: Force = F = 100 N $\Rightarrow$ Mass = m = 50 kg $\Rightarrow$ Acceleration = a = ?

F = ma $\Rightarrow$ or $a = \frac{F}{m} \Rightarrow a = \frac{100}{50} \Rightarrow a = 2\ ms^{-2}$

SECTION -- D (Marks 20)

Note: Attempt any TWO questions. All questions carry equal marks. (2 × 10 = 20)

Q.4 (a) State and prove Newton's second law of motion. OR Show that F = ma.

Ans: See Page # 86, Q3. (b) From FBISE Past Paper (2014).

(b) How much force is needed to prevent a body of mass 10 kg from falling?

Solution: Mass = m = 50 kg $\Rightarrow$ Acceleration = a = g = 10 ms^{-2}

Force = F = ? $\Rightarrow$ F = ma $\Rightarrow$ F = 10 ×10 $\Rightarrow$ F = 100 N

Q.5 (a) Law of conservation of momentum.

Ans: See Page # 95, Q3. (a) From FBISE Past Paper (2016).

(b) How much centripetal force is needed to make a body of mass 0.5 kg to move in a circle of radius 50 cm with a speed 3 ms^{-1}?

Solution: Mass = m = 0.5 kg $\Rightarrow$ Radius of the circle = r = 50 cm = $\frac{50}{100}$ = 0.5 m

Speed = v = 3 ms^{-1} $\Rightarrow$ Centripetal force = F_c = ?

$$F_c = \frac{mv^2}{r} \Rightarrow F_c = \frac{0.5 \times 3^2}{0.5} = \frac{0.5 \times 9}{0.5} = \frac{4.5}{0.5} = 9\ N$$

Q.6 (a) How can you relate a force with the change of momentum of a body? And what is law of inertia?

Ans: Force and the momentum:

Consider a body of mass m moving with initial velocity v_i. Let a force F acts on the body which produces an acceleration a in it. This changes the velocity of the body. Let its final velocity after time t becomes v_f. If P_i, and P_f be the initial momentum and final momentum of the body related to initial and final velocities respectively then

$$P_i = mv_i \quad \text{and} \quad P_f = mv_f$$

Change in momentum = final momentum - initial momentum

or $$P_f - P_i = mv_f - mv_i$$

Thus the rate of change in momentum is given by: $$\frac{P_f - P_i}{t} = \frac{mv_f - mv_i}{t}$$

Since $\frac{v_f - v_i}{t}$ is the rate of change of velocity equal to the acceleration a produced by the force F

$$\frac{P_f - P_i}{t} = ma$$

According to Newton's second law of motion,

Equation (i) also defines force and states Newton's second law of motion as:

When a force acts on a body, it produces an acceleration in the body and will be equal to rate of change of momentum of the body.

Inertia: Inertia of a body is its property due to which it any change in its state of rest or motion.

Galileo related the inertia of a body with its mass; greater is the mass of a body greater is its inertia.

Inertia $\propto$ mass of body

(b) How much is the force of friction between a wooden block of mass 5 kg and the horizontal marble floor? The coefficient of friction between wood and the marble is 0.6.

Solution: Mass = m = 5kg ; Coefficient of friction = μ = 0.6

Force of friction = F_s = ? ; $F_s = \mu R$ (where R = mg)

$\therefore$ $F_s = \mu mg$

$F_s = 0.6 \times 5 \times 10 = 30$ N

IMPORTANT QUESTIONS

Q1. Put a one rupee coin over a piece of card paper placed on an empty glass. Push the card with a sudden stroke of finger. Card will move ahead while the coin falls in the glass. Why it does so?

Ans: Due to inertia card will continue its motion in the forward direction while coin will remain at rest and will fall in the glass

Q2. Why the impact of a loaded truck on a body coming its way is very large even if the truck is moving slowly.

Ans: Greater is the mass of truck greater will be its momentum. Therefore loaded truck has large impact.

Q3. Why Newton's first law of motion is also known as law of inertia?

Ans: Since Newton's first law of motion deals with the inertial property of matter, therefore, Newton's first law of motion is also known as law of inertia.

Q4. Explain Newton's third law of motion by practical examples of daily life?

Ans: Newton's third law of motion:

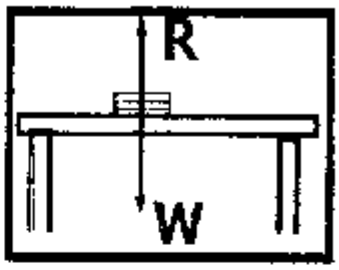
To every reaction there is always an equal but opposite reaction.

Note that action and reaction forces act on different bodies.

Examples:

Book lying on a table:

Consider a book lying on a table. The weight of the book is acting on the table in the downward direction. This is the action The reaction of the table acts on the book in the upward direction.



Action of the book and reaction on it

An air-filled balloon:

Take an air-filled balloon. When the balloon is set free, the air inside it rushes out and the balloon moves forward. In this example, the action is by the balloon that pushes the air out of it when set free. The reaction of the air which escapes out from the balloon acts on the balloon. It is due to this reaction of the escaping air that moves the balloon forward.

Taking off a rocket:

A rocket such moves on the same principle. When its fuel burns, hot gases escape out from its tail with a very high speed. The reaction of these gases on the rocket causes it to move opposite to the gases rushing out of its tail.

Q5. The weight of a body is 147 N. What is its mass? (Take the value of g as 10 ms^{-2})

Solution: Weight = w = 147 N $\Rightarrow$ Acceleration due to gravity = g = 10 ms^{-1}

Mass = m = ? $\Rightarrow$ $w = mg$ $m = \frac{w}{g}$

Q6. What do you know about the coefficient of friction?

Ans: Coefficient of friction (μ):

The ratio between the force of limiting friction F_s and the normal reaction R is constant. This constant is called the coefficient of friction and is represented by μ

Thus $\mu = \frac{F_s}{R}$ ..... (i) $\Rightarrow$ or $F_s = \mu R$ ..... (ii)

If m be the mass of the block, then for horizontal surface;

$R = mg$ ..... (iii) $\Rightarrow$ Hence $F_s = \mu mg$ ..... (iv)

Q7. The first thing about a wheel is that it rolls as it moves rather than to slide. This greatly reduces friction. Why?

Ans: When the axle of a wheel is pushed, the force of friction between the wheel and the ground at the point of contact provides the reaction force. The reaction force acts at the contact points of the wheel in a direction opposite to the applied force. The wheel rolls without rupturing the cold welds. That is why the rolling friction is extremely small than sliding friction.

Q8. Why ball bearing or roller bearings are used to reduce friction?

Ans: The fact that rolling friction is less than sliding friction is applied in ball bearings or roller bearings to reduce losses due to friction.

Q9. Do we roll or slide eraser to remove the pencil the work from our notebook?

Ans: The fact that sliding friction is greater than rolling friction We slide the eraser to remove the pencil work from our note book.

Q10. 1. In which case do you need smaller force and why? (i) rolling (ii) sliding

Ans: In case of rolling friction we need smaller force. Because the rolling friction is lesser than the sliding friction.

2. In which case it is easy for the tyre to roll over? (i) rough ground (ii) smooth ground

Ans: On the smooth ground, it is easy for the tyre to roll over due to less friction.

Q11. Describe the situations in daily life in which friction is most desirable?

Ans: Sometimes friction is most desirable. We cannot write if there would be no friction between paper and the pencil. Friction enables us to walk on the ground. We cannot run on a slippery ground.

A slippery ground offers very little friction. Hence, anybody who tries to run on a slippery ground may meet an accident. Similarly, it is dangerous to apply brakes with full force to stop a fast moving vehicle on a slippery road.

Birds could not fly, if there is no air resistance. The reaction of pushed air enables the birds to fly. Thus in many situations, we need friction while in other situations we need to reduce it as much as possible.

Q12. Write a dream during which you are driving a car and suddenly the friction disappears. What happened next...?

Ans: If suddenly the friction disappear then we cannot stop the car. Nothing would be steady on the ground, car would be just sliding and sliding.

Q13. Define the following terms: (i) Force (ii) Force of friction

Ans: (i) Force: A force moves or tends to move, stops or tends to stop the motion of a body. The force can also change the direction of motion of a body. $F = ma$

SI unit of force is newton.

Note: A force can also change the shape or size of a body on which it acts.

(ii) Force of friction: The force that opposes the motion of moving objects is called friction. Friction is a force that comes into action as soon as a body is pushed or pulled over a surface.

Factor on which friction depends:

In case of solids, the force of friction between two bodies depends upon many factors such as nature of the two surfaces in contact and the pressing force between them

Q14. What is the difference between action and reaction?

Ans: Action and reaction:

Newton's third law of motion deals with the reaction of a body when a force acts on it. Let a body A exerts a

Example:

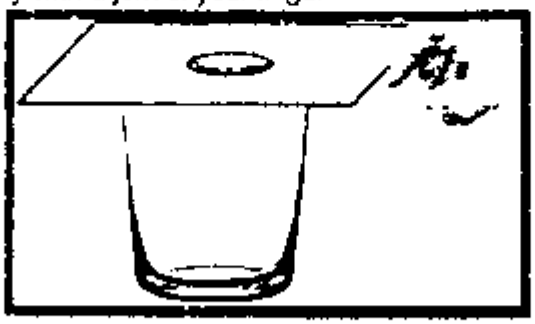
Action and reaction forces act on different objects, and in opposite directions. For example, if the rocket pushes the gas out, the gas pushes back against the rocket. The forces are on different objects (the gas, and the rocket, respectively), and in opposite directions.

Q15. What is the law of Inertia?

Ans: Inertia: Inertia of a body is its property due to which it any change in its state of rest or motion.
Galileo related the inertia of a body with its mass; greater is the mass of a body greater is its inertia.

Inertia ∝ mass of body

Experiment: Take a glass and cover it with a piece of cardboard. Place a coin on the cardboard. Now kick the card horizontally with a jerk of your finger



The coin falls into the glass as the card flicks away

The coin does not move with the cardboard due to inertia. The coin falls into the glass as the card flicks away

Experiment: Cut a strip of paper. Place it on the table. Stack a few coins at its one end. Pull out the paper strip under the coins with a jerk.

Coins stacked over remain undisturbed on pulling the paper strip quickly

Coins staked over remain undisturbed on pulling the paper strip quickly due to inertia.

Q16. Why is the law of conservation of momentum important?

Ans: Law of conservation of momentum is applicable on all objects in the universe. A rocket and jet engine taking off, the recoil of a gun, and a bank-shot in a pool are examples which demonstrate the importance of law of conservation of momentum.

Q17. Describe two situations in which force of friction is needed.

Ans:
i. Friction is needed to walk on the ground.
ii. It is risky to run on wet floor with shoes that have smooth soles. Athletes use special shoes that have extraordinary ground grip. Such shoes prevent them from slipping while running fast.
iii. To stop our bicycle we will apply brakes. The rubber pads pressed against the rims provide friction. It is the friction that stops the bicycle.

Q18. Describe ways to reduce friction.

Ans: Methods of reducing friction:

(i) The friction can be reduced by making the sliding surfaces smooth.

(ii) The friction can be reduced by making the fast moving objects a streamline shape (fish shape) such as cars, aeroplanes, etc. This causes the smooth flow of air and thus minimizes air resistance at high speeds.

(iii) The friction can be reduced by lubricating the sliding surfaces.

(iv) The friction can be reduced by using ball bearings or roller bearings. Because the rolling friction is

UNIT 4: TURNING EFFECTS OF FORCES

All Theory Topics 4.1- 4.8 are included.

NOTE:

- All mini exercises, quick quiz and side information are excluded.
- Only topic based related MCQs, Short and Long Questions and numerical are included.

GUESS PAPER & MODEL PAPER # 4
BASED ON UNIT # 4 (Reduced Syllabus)
TURNING EFFECT OF FORCES

SECTION-A

Time allowed: 20 Minutes **Marks: 12**

Note: Section-A is compulsory. All parts of this section are to be answered on the question paper itself. It should be completed in the first 20 minutes and handed over to the Centre Superintendent. Deleting/overwriting is not allowed. Do not use lead pencil.

Q.1 Encircle the correct option i.e. A / B / C / D. All parts carry equal marks.

i. Two equal but unlike parallel forces having different line of action produce.
A. a torque B. a couple C. equilibrium D. neutral equilibrium

ii. The number of forces that can be added by head to tail rule are:
A 2 B. 3 C. 4 D. any number

iii. The number of perpendicular components of a force are:
A. 1 B. 2 C. 3 D. 4

iv. A force of 10 N is making an angle of 30° with the horizontal. Its horizontal component will be:
A. 4 N B. 5 N C. 7 N D. 8.7 N

v. A couple is formed by:
A. two forces perpendicular to each other
B. two like parallel forces
C. two equal and opposite forces in the same line
D. two equal and opposite forces not in the same line

vi. A body is in equilibrium when its:
A. acceleration is uniform
B. speed is uniform
C. speed and acceleration are uniform
D acceleration is zero

vii. A body is in neutral equilibrium when its centre of gravity:
A. is at its highest position
B. is at the lowest position
C. keeps its height if displaced
D. is situated at its bottom

viii. Racing cars are made stable by:
A. increasing their speed
B. decreasing their mass
C. lowering their centre of gravity
D. decreasing their width

xi. How much force would be sufficient to loosen it with a 6 cm long spanner?
A. 12 N B. 22 N C. 250 N D. 30 N

xii. A force of 10 N acting on a body making an angle of 30° with the horizontal. The horizontal component of the force is _____.
A. 86.6 N B. 87 N C. 89.6 N D. 8.66 N

Time Allowed: 2:40 Minutes **Total Marks: 53**

Note: Answer any six parts from Section 'B' and attempt any five parts from Section-C. Attempt any two questions from Section 'D' on the separately provided answer book. Use supplementary answer sheet i.e. Sheet–B if required. Write your answers neatly and legibly

SECTION – B (Marks 18)

Q.2 Attempt any SIX parts from the following. All parts carry equal marks. (6 × 3 = 18)

(i) What is the Difference between torque and couple?
(ii) Why a vehicle is made heavy at its bottom?
(iii) Find the magnitude and direction of a force, if its x-component is 12N and y-component is 5N.
(iv) How head to tail rule helps to find the resultant of forces?
(v) Why the height of vehicles is kept as low as possible?
(vi) Does the fan satisfy second condition for equilibrium when rotating with uniform speed?
(vii) Define terminal velocity?
(viii) How does a paratrooper come down?

SECTION – C (Marks 15)

Q.3 Attempt any FIVE parts from the following. All parts carry equal marks. (5 × 3 = 15)

(i) Can a small child play with a fat child on the seesaw? Explain how?
(ii) DefineMoment arm?
(iii) Why it is easy to tighten a nut using a spanner of longer arm than a spanner of shorter arm
(iv) Why the handle of a door is fixed near the outer edge of a door?
(v) The steering of a car has a radius 16 cm. Find the torque produced by a couple of 50 N.
(vi) What do you mean by axis of rotation?
(vii) What do you mean by a rigid body?

SECTION – D (Marks 20)

Note: Attempt any TWO questions. All questions carry equal marks. (2 × 10 = 20)

Q.4 (a) Define couple. Describe its role in steering wheel double arm spanner?
(b) A picture frame is hanging by two vertical strings. The tensions in the strings are 3.8 N and 4.4 N. Find the weight of the picture frame.

Q.5 (a) Explain what is meant by stable, unstable and neutral equilibrium. Give one example in each case.
(b) A force is acting on a body making an angle of 30° with the horizontal. The horizontal component of the force is 20 N. Find the force.

Q.6 (a) How can a force be resolved into its rectangular components?
(b) Find the perpendicular components of a force of 50 N making an angle of 30° with x-axis.

SOLUTION OF GUESS PAPER & MODEL PAPER # 4
(Reduced Syllabus)

SECTION- A (MCQs)

SECTION

Q.2 Attempt any SIX parts from the fol **(6 x 3 = 18)**

(i) What is the Difference between

Ans: Difference between torque and co

Torque is a special kind of force that has t t about an axis. While a force is described as a push or a pull, it is better to think of torque

In a special case when applied force vectors a than the force is called a couple and their moment is called a torque. Thus the rotational for ment is called a couple.

When a driver turns a steering wheel, he exerts rces on it The two forces form a couple. The turning effect of a couple is the sum of m the two forces. The moment of a couple is called a torque.

(ii) Why a vehicle is made heavy at its bottom?

Ans: A vehicle is made heavy at its bottom to keep its centre of gravity as low as possible. A lower centre of gravity keeps it stable. Moreover, the base of a vehicle de so that the vertical line passing through its centre of gravity should not get out of its base during

(iii) Find the magnitude and direction of a force, if x-component is 12N and y-component is 5N.

Solution: $F_x = 12N \Rightarrow F_y = 5$

(i) Magnitude of the force = F = ?

(ii) Direction of the force = θ = ?

(i)

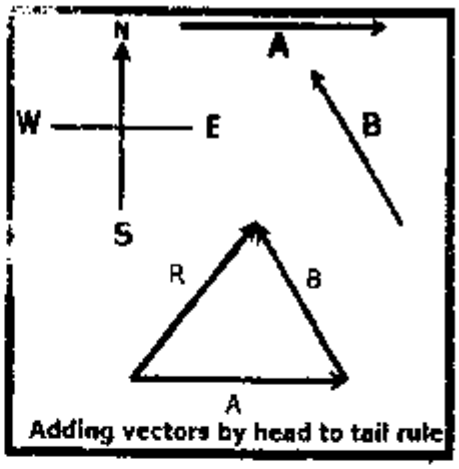
$$F = \sqrt{F_x^2 + F_y^2} \Rightarrow F = \sqrt{(12)^2 + (5)^2} \Rightarrow \sqrt{144 + 25} = \sqrt{169} \Rightarrow F = 13\ N$$

(ii) $\theta = \tan^{-1}\frac{F_y}{F_x} \Rightarrow \theta = \tan^{-1}\frac{12}{5} \Rightarrow \theta = \tan^{-1}(2.4) \Rightarrow \theta = 22.6°$ with x-axis

(iv) How head to tail rule helps to find the resultant

Ans: Addition of Vectors by head to tail rule:

To add the vectors, draw the representative lines of these vectors in such a way that the head of the first vector coincides with the tail of the second. The line joining the tail of the first vector to the head of the second vector represents the resultant vector in magnitude and direction of the resultant vector is from the tail of the first vector towards the head of the second. This is called head to tail rule



Adding vectors by head to tail rule

Note: It should be noted that head to tail rule can be used to add any number of forces. The vector representing resultant force gives the magnitude and direction of the resultant force.

(v) Why the height of vehicles is kept as low as possible?

Ans: As the whole weight of a body acts on centre of gravity so, in case of racing car centre of gravity must be close to the earth so that there are less chances of overturning of the car.

If the car is high, it is easy to produce the torque in car due to large moment arm, and the car can takes the somersault (forward roll).

(vi) Does the fan satisfy second condition for equilibrium when rotating with uniform speed?

Ans: Yes, a rotating ceiling fan satisfy second condition for equilibrium. Because ceiling fan rotating at constant speed is in equilibrium as net torque acting on it is zero. $\sum \tau = 0$

(vii) Define terminal velocity?

Ans: Terminal velocity:

The maximum and constant velocity of an object falling vertically downward is called terminal velocity.

$$Terminal\ velocity = V_t = \frac{2gr^2\rho}{}$$

(viii) How does a paratrooper come down?

Ans: A paratrooper comes down with terminal velocity is in equilibrium.

A paratrooper coming down with terminal velocity (constant velocity) also satisfies first condition for equilibrium and is thus in equilibrium.

SECTION – C (Marks 15)

Q.3 Attempt any FIVE parts from the following. All parts carry equal marks. **(5 × 3 = 15)**

(i) Can a small child play with a fat child on the seesaw? Explain how?

Ans: Yes, they can play on see saw, the fat child has larger weight that's mean larger force and smaller child has smaller weight and smaller force. So in order to play, larger weight should be at smaller distance from the centre of the see saw and the smaller weight should be at larger distance from the centre of the see-saw. In another situation a fat child cannot play with a small child if they have equal distances from the centre see-saw.

(ii) DefineMoment arm?

Moment arm:

The perpendicular distance between the axis of rotation and the line of action of the force is called the moment arm of the force. It is represented by the distance *L*.

(iii) Why it is easy to tighten a nut using a spanner of longer arm than a spanner of shorter arm

Ans: A spanner having long arm helps to loosen or tighten a nut or a bolt with greater ease than the one having short arm. It is because the turning effect (torque) of the force increases. ($\tau \propto L$)

(iv) Why the handle of a door is fixed near the outer edge of a door?

OR Why door handles usually on the opposite edge of the door from the hinge?

Ans: We can open or close a door more easily by applying a force at the outer edge of a door rather than near the hinge.

The moment produced by a force using a greater moment arm is greater than the torque produced by the same force using by shorter moment arm. Therefore the handle of a door is fixed near the outer edge of a door. ($\tau \propto L$)

(v) The steering of a car has a radius 16 cm. Find the torque produced by a couple of 50 N.

Solution: Radius = r = L = 16 cm = $\frac{16}{100}$ m = 0.16m

Couple arm = L = 16 cm = $\frac{16}{100}$ m = 0.16m

Force = F = 50 N $\Rightarrow$ Torque = τ = ?

$\tau = F \times L \Rightarrow \tau = 50 \times (2 \times 0.16) = 16$ Nm

(vi) What do you mean by axis of rotation?

Ans: Axis of rotation:

Consider a rigid body rotating about a line. The particles of the body move in circles with their centres all lying on this line. This line is called the axis of rotation of the body.

(vii) What do you mean by a rigid body?

Ans: Rigid body:

A body is composed of large number of small particles. If the distances between all pairs of particles of the body do not change by applying a force then it is called a rigid body.

In other words, a rigid body is the one that is not deformed by force or forces acting on it.

SECTION – D (Marks 20)

Note: Attempt any TWO questions. All questions carry equal marks. **(2 × 10 = 20)**

Q.4 (a) Define couple. Describe its role in steering wheel double arm spanner?

Ans: See Page # 89, Q3. From FBISE Past Paper (2015).

(b) A picture frame is hanging by two vertical strings. The tensions in the strings are 3.8 N and 4.4 N. Find the weight of the picture frame.

$\Sigma F_x = 0$ and $\Sigma F_y = 0$

Therefore $T - w = 0$

or $(T_1 + T_2) - w = 0 \Rightarrow T_1 + T_2 = w \Rightarrow 3.8 + 4.4 = w$

$w = 8.2$ N

Q.5 (a) Explain what is meant by stable, unstable and neutral equilibrium. Give one example in each case. OR

Briefly explain the states of equilibrium?

Ans: **See Page # 126, Q6. From FBISE Past Paper (2020).**

(b) A force is acting on a body making an angle of 30° with the horizontal. The horizontal component of the force is 20 N. Find the force.

Solution: Angle $\theta = 30°$ (with x-axis) $\Rightarrow$ Horizontal component of force $F_x = 20N$

Force $F = ? \Rightarrow F_x = F\cos\theta \Rightarrow 20N = F\cos 30°$

or $20N = F \times 0.866$; ($\because \cos 30° = 0.866$) $\Rightarrow$ or $F = \frac{20N}{0.866} = 23.09 = 23.1N$

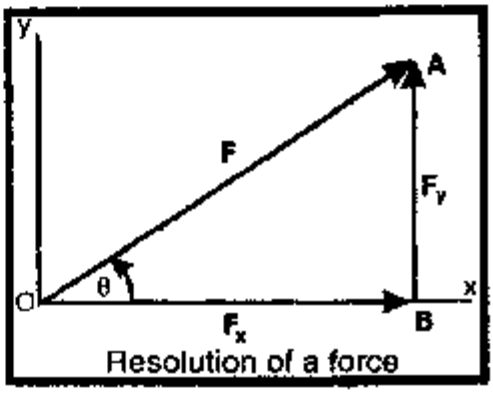
Q.6 (a) How can a force be resolved into its rectangular components?

Ans: Resolution of Forces/Resolution of vectors:

The process of splitting up vectors (forces) into their component forces is called resolution of forces.

OR

Splitting up of a force into two mutually perpendicular components is called the resolution of that force. Resolution of vectors is the reverse of vector addition.



Resolution of a force

Perpendicular component/Rectangular components:

If a force is formed from two mutually perpendicular components then such components are called its perpendicular components

Explanation: Consider a force F represented by line OA making an angle θ with x-axis.

Draw a perpendicular AB on x-axis from A.

According to head to tail rule, OA is the resultant of vectors represented by OB and BA.

Thus $OA = OB + BA$ ..... (1)

From figure $F = F_x + F_y$ ..... (2)

Magnitude of horizontal component (F_x):

In right angled triangle OBA

$$\cos\theta = \frac{\text{Base}}{\text{Hypotenuse}} = \frac{OB}{OA}$$

$$\frac{F_x}{F} = \cos\theta$$

$$F_x = F\cos\theta \quad \text{.....} \quad (3)$$

Magnitude of vertical component (F_y):

$$\sin\theta = \frac{\text{Prependicular}}{\text{Hypotenuse}} = \frac{BA}{OA}$$

$$\frac{F_y}{F} = \sin\theta$$

$$\therefore F_y = F\sin\theta \quad \text{.....} \quad (4)$$

Equations (3) and (4) give the magnitude of perpendicular components F_x and F_y respectively.

(b) Find the perpendicular components of a force of 50 N making an angle of 30° with x axis.

Solution: Force $F = 50N \Rightarrow$ Angle $\theta = 30° \Rightarrow F_x = ?$ and $F_y = ?$

$F_x = F\cos\theta \Rightarrow F_x = 50 \times \cos 30° = 50N \times 0.866$ ($\because \cos 30° = 0.866$)

$F_x = 43.3N$

IMPORTANT QUESTIONS

Q1. Can the nut of the axle of a bike be loosened with hand why we use a spanner for this purpose?

Ans: No, we cannot loosen the nut of the excel of a bike. Normally we use a spanner because a spanner increases the turning effect of the force which easily loosened the nut of excel of a bike.

Q2. Women and children in the villages often carry pitchers with water on their heads how this is possible?

Ans: Woman and children keep itself upright when carry pitchers on their heads. Pitcher has a heavy semi-spherical base. When it is tilted, its centre of mass rises. It returns to its upright position at which its centre of mass is at the lowest.

That is why Women and children in the villages often carry pitchers with water on their heads.

Q3. With a little effort we can learn to balance a stick vertically up on our finger tip how this is possible.

Ans: In order to balance something, all you need to do is make sure that the center of gravity of the object is either directly above or directly below the pivot point. An example would be balancing the stick on the end of a finger with the stick pointing vertically up. If you do this you will find that the stick wants to fall over, and you need to keep moving your finger around to keep this from happening

Q4. What is meant by parallel forces?

Ans: Parallel Forces:

In a plane, if a number of forces act on a body such that their points of action are different but lines of action are parallel to each other, then these forces are called parallel forces.

Q5. Many people push a bus to start it why all of them push it in the same direction?

Ans: Like parallel forces acting in the same direction increases the resultant force which moves the bus easily.

Q6. Why it is easy to open and close the door by pulling or pushing it at its handle?

Ans: We open or close a door by pushing or pulling it. Here push or pull turn the door about its hinge or **axis of rotation**. The door is opened or closed due to the **turning effect** of the force acting on it.

Q8. Describe principle of moment?

Ans: Principle of moments: According to the principle of moments:

A body is balanced if the sum clockwise moments acting on the body is equal to the sum of anticlockwise moments acting on it.

Explanation:

Clockwise moment: A force that turns a spanner in the clockwise direction is generally used to tighten a nut. The torque or moment of the force so produced is called **clockwise moment**.

(a) to tighten, nut is turned clockwise (b) to loosen, nut is turned anticlock

Anticlockwise moment:

On the other hand, to loosen a nut, the force is applied such that it turns the nut in the anticlockwise direction. The torque or moment of the force so produced is called **anticlockwise moment**.

Note: A body initially at rest does not rotate if sum of all the clockwise moments acting on it is balanced by the sum of all the anticlockwise moments acting on it. This is known as the principle of moments.

Q12. Define the following: (i) resultant vector (ii) centre of mass

Ans: (i) Resultant vector:

A resultant vector is a single vector that has the same effect as the combined effect of all the vectors to be added.

OR

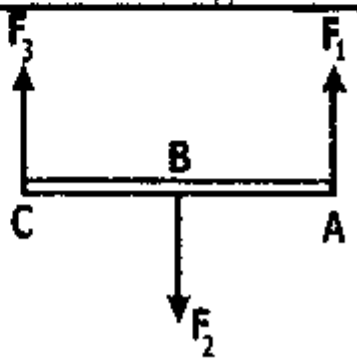
The sum of two or more vector is a single vector which has the same effect as the combined effect of all the vectors to be added. This single vector is called resultant vector.

(ii) Centre of mass:

Centre of mass of a system is such a point where an applied force causes the system to move without rotation.

Q13. Differentiate between like and unlike forces

Ans: Difference between like and unlike forces

Like parallel force	Unlike parallel force
Like parallel forces are the forces that are parallel to each other and have the same direction.	Unlike parallel forces are the forces that are parallel but have directions opposite to each other.
Explanation: The forces F_1, F_2 and F_3 are acting at points A, B and C respectively. Since the direction of the applied forces F_1 and F_3 is the same, so these are like parallel forces. The applied forces F_1, F_2 and F_2, F_3 are acting in the opposite direction, so these are unlike parallel forces.	

Q14. When a body is said to be in equilibrium?

Ans: Equilibrium:

A body is said to be in equilibrium if no net force acts on it A body in equilibrium thus remains at rest or moves with uniform velocity.

Examples: A car moving with uniform velocity on a levelled road and an aeroplane flying in the air with uniform velocity are the examples of bodies in equilibrium.

Conditions for equilibrium:

In the above examples, we see that a body at rest or in uniform motion is in equilibrium if the resultant force acting on it is zero. For a body in equilibrium, it must satisfy certain conditions. There are two conditions for a body to be in equilibrium.

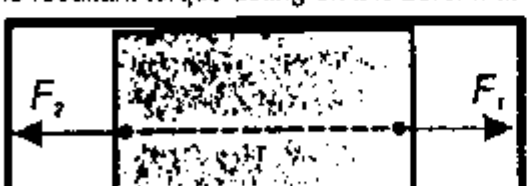
Q15. Why there is a need of second condition for equilibrium if a body satisfies first condition for equilibrium?

Ans: Case I:

First condition for equilibrium does not ensure that a body is in equilibrium Consider a body pulled by the forces F_1 and F_2. The two forces are equal but opposite to each other. Both are acting along the same line, hence their resultant will be zero. According to the first condition, the body will be in equilibrium.

Case II:

Now shift the location of the forces as shown in figure In this situation, the body is not in equilibrium although the first condition for equilibrium is still satisfied. It is because the body has the tendency to rotate. This situation demands another condition for equilibrium in addition to the first condition for equilibrium. This is called **second condition for equilibrium**. According to this, a body satisfies second condition for equilibrium when the resultant torque acting on it is zero. Mathematically, $\sum \tau = 0$



Q16. What is second condition for equilibrium?

Ans: Second condition for equilibrium:

A body satisfies second condition for equilibrium when the resultant torque acting on it is zero. Mathematically, $\sum \tau = 0$

Q17. Give an example of a moving body which is in equilibrium.

Ans: A car moving with uniform velocity on a levelled road and an aeroplane flying in the air with uniform velocity are the examples of bodies in equilibrium.

A parartrooper coming down with terminal velocity (constant velocity) also satisfies first condition for equilibrium and is thus in equilibrium.

Q18. Think of a body which is at rest but not in equilibrium.

Ans: Rest implies stationary, equilibrium implies a resultant force of zero. Therefore, a body in equilibrium could be moving, for example a sky diver at terminal velocity, where resistive forces are equal to the force of gravity. This means that a body can be in equilibrium and not at rest, but a body at rest must be in equilibrium, otherwise it would move. So, to answer the question is: It's impossible.

Q19. Why a body cannot be in equilibrium due to single force acting on it?

Ans: No, with only a single force present, the body would accelerate infinitely in the direction of that force

Because the force which is alone applied will have some direction and the object will try to move in this direction under its influence. However, if two opposite and equal forces take part it, gives rise to a null vector force. The body can be in rotational equilibrium under the impact of a single force.

Q20. Find the resultant of the following forces:

(i) 10 N along x-axis (ii) 6 N along y-axis and (iii) 4 N along negative x-axis.

Solution: F_x = Net force along x-axis = 10 - 4 = 6 N $\Rightarrow$ F_y = Force along y-axis = 5 N

Magnitude of the resultant force = F = ? $\Rightarrow$ Direction of the force = θ = ?

$$F = \sqrt{F_x^2 + F_y^2} \quad \Rightarrow \quad F = \sqrt{(6)^2 + (6)^2} \quad \Rightarrow \quad F = \sqrt{36+36} = \sqrt{72} = 8.5 \text{ N}$$

Now, $\theta = \tan^{-1}\frac{F_y}{F_x} \Rightarrow \theta = \tan^{-1}\frac{6}{6} \Rightarrow \theta = \tan^{-1}(1) \Rightarrow \theta = 45^\circ$ with x-axis

Q21. A force of 100 N is applied perpendicularly on a spanner at a distance of 10 cm from a nut. Find the torque produced by the force.

Solution: Force = F = 100 N $\Rightarrow$ Distance = L = 10 cm = 0.1 m

Torque = τ = ? $\Rightarrow$ $\tau = F \times L \Rightarrow \tau = 100 \times 0.1 = 100 \times \frac{1}{10} = 10$ Nm

Q22. Two blocks of masses 5 kg and 3 kg are suspended by the two strings as shown. Find the tension in each string. (80 N, 30 N)

Solution: Mass of large block = M = 5 kg

Mass of small block = m = 3 kg

Tension produced in each string = T_1 = ? and T_2 = ?

$T_1 = w_1 + w_2 \Rightarrow T_1 = mg + Mg \Rightarrow T_1 = (m + M)g$

$T_1 = (3 + 5) \times 10 = 8 \times 10 = 80$ N

Also, $T_2 = mg \Rightarrow T_2 = 3 \times 10 = 30$ N

Q23. A nut has been tightened by a force of 200 N using 10 cm long spanner. What length of a spanner is required to loosen the same nut with 150 N force?

Solution: Force = F_1 = 200 N

$\Rightarrow$ Length = $L_1 = 10 \text{ cm} = \frac{10}{100} = 0.1$ m

Length of the spanner to tighten the same nut:

Force = F_2 = 150 N $\Rightarrow$ Length = L_2 = ?

$$L_2 = \frac{20}{150} = 0.133\ m = 0.133 \times 100 = 13.3\ cm$$

Q24. A block of mass 10 kg is suspended at a distance of 20 cm from the centre of a uniform bar 1 m long. What force is required to balance it at its centre of gravity by applying the force at the other end of the bar?

Solution: Mass of the block = m = 10 kg
Length of the bar = l = 1 m
Moment arm of $w_1 = L_1 = 20$ cm = 0.2 m
Moment arm of $w_2 = L_2 = 50$ cm = 0.5 m
Force required to balance the bar F_2 = ?

By applying principle of moments: Clockwise moments = Anticlockwise moments

Thus $F_1 \times L_1 = F_2 \times L_2 \Rightarrow mg \times L_1 = F_2 \times L_2 \Rightarrow (10 \times 10) \times 0.2 = F_2 \times 0.5$

$20 = F_2 \times 0.5 \Rightarrow F_2 = \frac{20}{0.5} = \frac{200}{5} = 40$ N

UNIT 5: GRAVITATION

5.1: The force of gravitation
5.2: Mass of Earth
5.3: Variation of g with Altitude

NOTE:

- All mini exercises, quick quiz and side information are excluded.
- Only topic based related MCQs, Short and Long Questions and numerical are included.

GUESS PAPER & MODEL PAPER # 5
BASED ON UNIT # 5 (Reduced Syllabus)
GRAVITATION

SECTION-A

Time allowed: 20 Minutes **Marks: 12**

Note: Section-A is compulsory. All parts of this section are to be answered on the question paper itself. It should be completed in the first 20 minutes and handed over to the Centre Superintendent. Deleting/overwriting is not allowed. Do not use lead pencil.

Q.1 Encircle the correct option i.e. A / B / C / D. All parts carry equal marks.

i. Earth's gravitational force of attraction vanishes at
A. 6400 km B. infinity C. 42300 km D 1000 km

ii. Value of *g* increases with the
A. increase in mass of the body B. increase in altitude
C. decrease in altitude D. none of the above

iii. The value of *g* at a height one Earth's radius above the surface of the Earth is:
A. $2g$ B. $\frac{1}{2}g$ C. $\frac{1}{3}g$ D. $\frac{1}{4}g$

iv. The value of g on moon's surface is 1.6 ms^{-2}. What will be the weight of a 100 kg body on the surface of the moon?
A. 100 N B. 160 N C. 1000 N D. 1600 N

v. The gravitational field is directed
A. towards the earth
B. away from earth
C. has no direction
D. in a specific direction making angle with earth

vi. The force due to which everybody of the universe attracts every other body
A. force of gravitation B. force of limiting friction
C. force of inertia D. force of mechanics

vii. Acceleration g on surface of earth is

viii. Mass of Earth M_e = _____

A. $\frac{R\ g}{G}$ B. $\frac{R^2\ g}{G}$ C. $\frac{R^2\ G}{g}$ D. $\frac{R\ G}{g}$

ix. The value of g at an altitude h = _____

A $G\frac{M}{(R+h)}$ B. $G\frac{m}{(R+h)^2}$ C. $G\frac{M}{(r+h)^2}$ D. $G\frac{M}{(R+h)^2}$

x. The value of g at Sun is _____.

A. 274.2 ms^{-2} B. 274.5 ms^{-2} C. 274.3 ms^{-2} D. 274.4 ms^{-2}

xi. The value of g at Jupiter is _____.

A. 25.99 ms^{-2} B. 25.94 ms^{-2} C. 25.92 ms^{-2} D. 25.93 ms^{-2}

Time Allowed: 2:40 Minutes **Total Marks: 53**

Note: Answer any six parts from Section 'B' and attempt any five parts from Section-C. Attempt any two questions from Section 'D' on the separately provided answer book. Use supplementary answer sheet i.e. Sheet-B if required. Write your answers neatly and legibly

SECTION – B (Marks 18)

Q.2 Attempt any SIX parts from the following. All parts carry equal marks. (6 × 3 = 18)

(i) Does the weight of an apple increase, decrease or remain when taken to the top of a mountain?

(ii) Do you attract the Earth or the Earth attracts you? Which one is attracting with a larger force? You or the Earth.

(iii) The acceleration due to gravity on the surface of moon is 1.62 ms^{-2}. The radius of Moon is 1740 km. Find the mass of moon.

(iv) What is meant by the force of gravitation?

(v) What is a field force?

(vi) Why earlier scientists could not guess about the gravitational force?

(vii) Explain, what is meant by gravitational field strength?

(viii) Find the gravitational force of attraction between two spheres each of mass 1000 kg. The distance between the centers of the spheres is 0.5 m.

SECTION – C (Marks 15)

Q.3 Attempt any FIVE parts from the following. All parts carry equal marks. (5 × 3 = 15)

(i) Why does the value of *g* vary from place to place?

(ii) Can you determine the mass of our moon? If yes, then what you need to know?

(iii) Why law of gravitation is important to us?

(iv) What is the effect of the following on the gravitational acceleration?

a. Mass of a freely falling body.

b. Distance of freely falling body from the centre of the Earth.

c. Is there any difference between the values of g at the equator and at the poles? Explain.

(v) At what altitude the value of *g* would become one fourth than on the surface of the Earth? (one Earth's radius)

(vi) The value of g is 4.0 ms^{-2} at a distance of 10000 km from the centre of the Earth. Find the mass of the Earth.

(vii) How can you say that gravitational force is a field force?

SECTION – D (Marks 20)

Note: Attempt any TWO questions. All questions carry equal marks. (2 × 10 = 20)

(b) Find the acceleration due to gravity on the surface of the Mars. The mass of Mars is 6.42×10^{23} kg and its radius is 3370 km.

Q.6 (a) Explain how the value of g varies with altitude.

(b) The gravitational force between two identical lead spheres kept at 1 m apart is 0.006673 N. Find their masses.

SOLUTION OF GUESS PAPER & MODEL PAPER # 5
(Reduced Syllabus)

SECTION- A (MCQs)

i. B	ii. C	iii. D	iv. B	v. D	vi. D
vii. A	viii. B	ix. D	x. A	xi. B	xii. C

SECTION – B (Marks 18)

Q.2 Attempt any SIX parts from the following. All parts carry equal marks. $(6 \times 3 = 18)$

(i) Does the weight of an apple increase, decrease or remain when taken to the top of a mountain?

Ans: The value of g varies inversely as the square of the distance i.e. $g \propto \frac{1}{R^2}$.

Therefore the weight of an apple, decrease when taken to the top of a mountain due to less gravity of Earth.

(ii) Do you attract the Earth or the Earth attracts you? Which one is attracting with a larger force? You or the Earth.

Ans: The answer of the question can be found two ways. First, we can use Newton's Third Law. If object "A" exerts a force on object "B", then object "B" will exert an equal force back on "A". This makes it pretty clear the forces are equal.

Second, we can use Newton's Law of Gravitational force. "The force that one mass exerts on a second mass is proportional to the product of the two masses". This means if we calculate the force the Earth exerts on us, we multiply the Earth's mass times our mass. And if we calculate the force we exert on the Earth ,we again multiply the two masses. Another words we do the exact same calculation, so we will get the same answer.

(iii) The acceleration due to gravity on the surface of moon is 1.62 ms^{-2}. The radius of Moon is 1740 km. Find the mass of moon.

Solution: Acceleration due to gravity = $g_m = 1.62\ ms^{-2}$

Radius of moon = $R_m = 1740\ km = 1740 \times 1000\ m = 1.74 \times 10^6\ m$

Mass of moon = $M_m = ?$

$$g_m = \frac{GM_m}{R^2_m}$$

or $$M_m = \frac{g_m \times R^2_m}{G}$$

$$M_m = \frac{1.62 \times (1.74 \times 10^6)^2}{6.673 \times 10^{-11}} = \frac{1.62 \times 3 \times 10^{12}}{6.673 \times 10^{-11}} = \frac{4.86 \times 10^{12} \times 10^{11}}{6.673}$$

$$M_m = 7.35 \times 10^{22}\ kg$$

(iv) What is meant by the force of gravitation?

Ans: The force of gravitation:

There exists a force due to which everybody of the universe attracts every other body. This force is called the force of gravitation.

(v) What is a field force?

(vi) Why earlier scientists could not guess about the gravitational force?

Ans: Earlier scientists could not guess the force of gravitation between two masses, because it is of very small value. It could be detected only by very sensitive instrument which were not invented at that time.

(vii) Explain, what is meant by gravitational field strength?

Ans: Gravitational field strength:

In the gravitational field of the Earth, the gravitational force per unit mass is called the gravitational field strength of the Earth. It is $10\ N\ kg^{-1}$ near the surface of the Earth.

The gravitational field becomes weaker and weaker as we go farther and farther away from the Earth. At any place its value is equal to the value of g at that point.

(viii) Find the gravitational force of attraction between two spheres each of mass 1000 kg. The distance between the centres of the spheres is 0.5 m.

Solution: Mass = $m_1 = m_2 = 1000$ kg

Distance between the centres = d = 0.5 m

Gravitational constant = $G = 6.673 \times 10^{-11}\ Nm^2kg^{-2}$

Gravitational force = F = ?

$$F = G\frac{m_1 m_2}{d^2}$$

$$F = 6.673 \times 10^{-11} \times \frac{1000 \times 1000}{(0.5)^2}$$

$$= 6.673 \times 10^{-11} \times \frac{(10)^6}{0.25} = \frac{6.673 \times 10^{-11} \times 10^6}{0.25} = \frac{6.673 \times 10^{-5}}{0.25}$$

$$= 26.692 \times 10^{-5} = 2.67 \times 10^{-4}\ N$$

SECTION – C (Marks 15)

Q.3 Attempt any FIVE parts from the following. All parts carry equal marks. (5 × 3 = 15)

(i) Why does the value of *g* vary from place to place?

Ans: Variation of g with altitude:

The value of g is inversely proportional to the square of the radius of the Earth ($g \propto \frac{1}{R^2}$).

But it does not remain constant. It decreases with altitude Altitude is the height of an object or place above sea level. The value of g is greater at sea level than at the hills.

(ii) Can you determine the mass of our moon? If yes, then what you need to know?

Ans: Yes, we can find the mass of moon by using the law of gravitation.

$$M_m = \frac{R^2 g_m}{G}$$

Where M_m = mass of moon

R = radius of moon

g_m = gravitational acceleration on moon

G = gravitational constant = $6.673 \times 10^{-11}\ Nm^2kg^{-2}$

(iii) Why law of gravitation is important to us?

Ans: Importance of law of gravitation:

As universal law of gravitation is important in releasing satellites from the earth in the orbits and it also gives the reason that why earth revolves around the sun.

The universal law of gravitation describes the phenomenon like the gravitational force between a planet and a star, rotation and revolution of heavenly bodies and galaxies

(iv) What is the effect of the following on the gravitational acceleration?

a. Mass of a freely falling body.

b. Distance of freely falling body from the centre of the Earth.

This means that light and heavy bodies should fall toward the centre of earth with the same acceleration.

(b) The value of g varies inversely as the square of the distance i.e. $g \propto \frac{1}{R^2}$ the distance from the centre of the earth is increased then the value of g will decrease. That is why the value of g at hills (Murree) is less than its value on the sea shore (Karachi).

(c) Earth is not a perfect sphere. It is flattened at the poles for this reason the value of g at the pole is more than at the equator. Because polar radius is less than equatorial radius. ($g \propto \frac{1}{R^2}$)

(v) At what altitude the value of *g* would become one fourth than on the surface of the Earth? (one Earth's radius)

Solution: **See Page # 122, Q2. (viii) From FBISE Past Paper (2020).**

(vi) The value of g is 4.0 ms^{-2} at a distance of 10000 km from the centre of the Earth. Find the mass of the Earth.

Solution: Gravitational acceleration =g = 4.0ms^{-2}
Radius of Earth = R_e = 10000km = 10000 × 1000 m = 10^7 m
Mass of Earth = M_e = ?

$$M_e = \frac{g R^2}{G}$$

$$M_e = \frac{4.0 \times (10^7)^2}{6.673 \times 10^{-11}} = \frac{4.0 \times 10^{14}}{6.673 \times 10^{-11}} = \frac{4.0 \times 10^{14}}{6.673 \times 10^{-11}} = 0.599 \times 10^{25} = 5.99 \times 10^{24} \text{ kg}$$

(vii) How can you say that gravitational force is a field force?

Ans: It is true that the force of gravity can be described as a force field. Any object having mass will create a gravitational attraction in all directions, with decreasing intensity as the distance from the object increases.

The weight of a body is due to the gravitational force with which the Earth attracts a body. Gravitational force is a non-contact force.

For example, the velocity of a body, thrown up, goes on decreasing while on return its velocity goes on increasing. This is due to the gravitational pull of the Earth acting on the body whether the body is in contact with the Earth or not. Such a force is called the **field force**. It is assumed that a **gravitational field** exists all around the Earth.

Note: According to the above equation, we come to know that at a height equal to one Earth radius above the surface of the Earth, g becomes one fourth $(\frac{1}{4})^{th}$ of its value on the Earth.

Similarly at a distance of two Earths radius above the Earth's surface, the value of g becomes one ninth $(\frac{1}{9})^{th}$ of its value on the Earth.

SECTION – D (Marks 20)

Note: Attempt any TWO questions. All questions carry equal marks. **(2 × 10 = 20)**

Q.4 (a) Explain gravitational field as an example of field of force.

Ans: Gravitational field:

The field in a region in space in which a particle would experience a gravitational force is called gravitational field.

It is assumed that a gravitational field exists all around the Earth due to the gravitational force of attraction of the Earth.

The weight of a body is due to the gravitational force with which the Earth attracts a body. Gravitational force is a non-contact force.

For example, the velocity of a body, thrown up, goes on decreasing while on return its velocity goes on increasing. This is due to the gravitational pull of the Earth acting on the body whether the body is in contact with the Earth or not.

(b) Calculate the value of *g* at a height of 3600 km above the surface of the Earth.

Solution: Height = h = 3600 km = 3600×1000 m = 3.6×10^6 m

Mass of Earth = $M_e = 6.0 \times 10^{24}$ kg

Gravitational acceleration g_h = ?

$$g_h = \frac{GM_e}{(R_e+h)^2}$$

$$g_h = 6.673 \times 10^{-11} \times \frac{6.0 \times 10^{24}}{(6.4 \times 10^6 + 3.6 \times 10^6)^2}$$

$$= 6.673 \times 10^{-11} \times \frac{6.0 \times 10^{24}}{(10.0 \times 10^6)^2} = 6.673 \times 10^{-11} \times \frac{6.0 \times 10^{24}}{100 \times 10^{12}}$$

$$= 6.673 \times 10^{-11} \times 6.0 \times 10^{10} = 40 \times 10^{-1} = 4.0 \text{ ms}^{-2}$$

Q.5 (a) Explain the law of gravitation. How the mass of Earth can be determined?

Ans: **See Page # 80, Q3. (a) From FBISE Past Paper (2013).**

(b) Find the acceleration due to gravity on the surface of the Mars. The mass of Mars is 6.42×10^{23} kg and its radius is 3370 km.

Solution: Mass of Mars = $M_m = 6.42 \times 10^{23}$ kg

Radius of Mars = $R_m = 3370$ km = 3370×1000 m = 3.37×10^6 m

Acceleration due to gravity on the surface of Mars = g_m = ?

OR $$g_m = G\frac{M_m}{R^2_m}$$

$$g_m = 6.673 \times 10^{-11} \times \frac{6.42 \times 10^{23}}{(3.37 \times 10^6)^2} = \frac{6.673 \times 10^{-11} \times 6.43 \times 10^{23}}{11.357}$$

$$= \frac{42.84}{11.357} = 3.77 \text{ ms}^{-2}$$

Q.6 (a) Explain how the value of g varies with altitude.

Ans: Variation of g with altitude:

Equation $g = G\frac{M_e}{R^2}$ shows that, the value of acceleration due to gravity g depends on the radius of the Earth at its surface.

The value of g is inversely proportional to the square of the radius of the Earth ($g \propto \frac{1}{R^2}$).

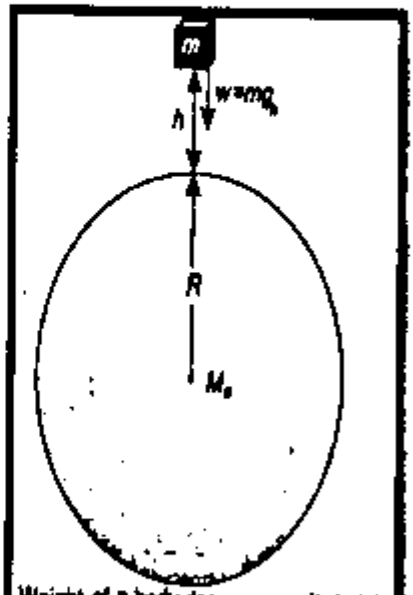
But it does not remain constant. It decreases with **altitude** Altitude is the height of an object or place above sea level. The value of g is greater at sea level than at the hills.

Explanation:

Consider a body of mass m at an altitude h. The distance of the body from the centre of the Earth becomes $R + h$.

Therefore, using equation ($g = G\frac{M_e}{R^2}$),

We get $$g_h = G\frac{M_e}{(R+h)^2} \quad \ldots\ldots\ldots\ldots \text{(i)}$$



Note:

According to the above equation, we come to know that at a height equal to one Earth radius above the surface of the Earth, g becomes one fourth ($\frac{1}{4}$) of its value on the Earth.

Similarly at a distance of two Earths radius above the Earth's

(b) The gravitational force between two identical lead spheres kept at 1 m apart is 0.006673N. Find their masses.

Solution: Gravitational force = F = 0.006673 N

Gravitational constant = G = 6.673×10^{-11} Nm^2kg^{-2}

Distance between the masses = d = 1m

Masses = $m_1 = m_2 = ?$

$$F = G\frac{m_1 m_2}{d^2} \quad \Rightarrow \quad \text{or} \quad F = G\frac{m \times m}{d^2}$$

(Let $m_1 = m_2 = m$)

$$\text{or} \quad F = G\frac{m^2}{d^2} \quad \Rightarrow \quad \text{or} \quad m^2 = \frac{F \times d^2}{G}$$

$$m^2 = \frac{0.00673 \times (1)^2}{6.673 \times 10^{-11}} = \frac{\frac{6673}{1000000}}{6.673 \times 10^{-11}} = \frac{6.673 \times 10^{-3}}{6.673 \times 10^{-11}}$$

$$m^2 = 10^8 \Rightarrow \sqrt{m^2} = \sqrt{10^8}$$

$$\Rightarrow \quad m = 10^4 = 10000 \text{ kg each}$$

Therefore, mass of each lead sphere is 10000kg.

UNIT 6: WORK AND ENERGY

Theory Topics (6.1-6.4), 6.8- efficiency, 6.9- power

NOTE:

- All mini exercises, quick quiz and side information are excluded.
- Only topic based related MCQs, Short and Long Questions and numerical are included.

GUESS PAPER & MODEL PAPER # 6
BASED ON UNIT # 6 (Reduced Syllabus)
WORK AND ENERGY

SECTION-A

Time allowed: 20 Minutes **Marks: 12**

Note: Section-A is compulsory. All parts of this section are to be answered on the question paper itself. It should be completed in the first 20 minutes and handed over to the Centre Superintendent. Deleting/overwriting is not allowed. Do not use lead pencil.

Q.1 Encircle the correct option i.e. A / B / C / D. All parts carry equal marks.

i. The work done will be zero when the angle between the force and the distance is
A. 45° B. 60° C. 90° D. 180°

ii. If the direction of motion of the force is perpendicular to the direction of motion of the body, then work done will be
A. Maximum B Minimum C. zero D. None of the above

iii. If the velocity of a body becomes double, then its kinetic energy will
A. remain the same B. become double
C. become four times D. become half

iv. The work done in lifting a brick of mass 2 kg through a height of 5 m above ground will be
A. 2.5 J B. 10 J C. 50 J D. 100 J

v. The kinetic energy of a body of mass 2 kg is 25 J. its speed is
A. 5 ms^{-1} B. 12.5 ms^{-1} C. 25 ms^{-1} D. 50 ms^{-1}

vi. (Force x displacement) is equal to
A. energy B torque C. power D. work

vii. When a body, is lifted through a height h, the work done on it appears in the form of its:
A. kinetic energy B. potential energy
C. elastic potential energy D. geothermal energy

viii. Maryam carries a 12 kg bag upstairs to a height of 15 steps. The amount of work she has done is
A 270 J B 210 J C. 250 J D. 300 J

ix. A metal box of mass 400 kg strikes the ground with the velocity of 30 ms-1. The kinetic energy will be

xi. Rate of doing work is called
A. energy B. torque C. power D. momentum.

xii. Efficiency of Petrol Engine is _____
A. 25% B. 35% C. 26% D. 30%

Time Allowed: 2:40 Minutes **Total Marks: 53**

Note: Answer any six parts from Section 'B' and attempt any five parts from Section-C. Attempt any two questions from Section 'D' on the separately provided answer book. Use supplementary answer sheet i.e. Sheet-B if required. Write your answers neatly and legibly

SECTION – B (Marks 18)

Q.2 Attempt any SIX parts from the following. All parts carry equal marks. (6 × 3 = 18)

(i) Define work. What is its SI unit?
(ii) When does a force do work? Explain.
(iii) Define energy, give two types of mechanical energy.
(iv) A man has pulled a cart through 35 m applying a force of 300 N. Find the work done by the man.
(v) Why do we need energy?
(vi) What is meant by the efficiency of a system?
(vii) Explain potential energy and derive its relation.
(viii) What is meant by the term power?

SECTION – C (Marks 15)

Q.3 Attempt any FIVE parts from the following. All parts carry equal marks. (5 × 3 = 15)

(i) Define watt.
(ii) A block weighing 20 N is lifted 6 m vertically upward. Calculate the potential energy stored in it.
(iii) A crate is moved by pulling the rope attached to it. It moves 10 m on a straight horizontal road by a force of 100 N. How much work will be done if;
1. The rope is parallel to the road.
2. The rope is making an angle of 30° with the road.

(iv) Differentiate energy resources as renewable and non-renewable resources of energy with examples of each?
(v) How can you find the efficiency of a system?
(vi) State mass energy equation $E = mc^2$.
(vii) A man pulls a block with a force of 300 N through 50 m in 60 s. Find the power used by him to pull the block.

SECTION – D (Marks 20)

Note: Attempt any TWO questions. All questions carry equal marks. (2 × 10 = 20)

Q.4 (a) Define K.E. and derive its relation.
(b) A 500 g stone is thrown up with a velocity of 15 ms^{-1}. Find its
(i) P.E. at its maximum height (ii) K.E. when it hits the ground

Q.5 (a) What is meant by the efficiency of a system?
(b) A car weighing 12 kN has speed of 20 ms^{-1}. Find its kinetic energy.

Q.6 On reaching the top of a slope 6 m high from its bottom, a cyclist has a speed of 1.5 ms^{-1}.

SOLUTION OF GUESS PAPER & MODEL PAPER # 6
(Reduced Syllabus)

SECTION- A (MCQs)

i. C	ii. C	iii. C	iv. D	v. A	vi. D
vii. B	viii. A	ix. B	x. B	xi. C	xii. A

SECTION – B (Marks 18)
(Chapter 6)

Q.2 Attempt any SIX parts from the following. All parts carry equal marks. **(6 × 3 = 18)**

(i) Define work. What is its SI unit?

Ans: Work: Work is done when a force acting on a body displaces it in the direction of a force.

Work is a scalar quantity. It depends on the force acting on a body, displacement of the body and the angle between them. $\text{Work done} = \text{Force} \times \text{displacement}$

or $W = FS$ ..... (i)

$W = F_x \times S \Rightarrow W = (F\cos\theta)S \Rightarrow W = FS\cos\theta$ ..... (ii)

Unit of work: SI unit of work is joule (J). It is defined as

The amount of work is one joule when a force of one newton displaces a body through one metre in the direction of force.

Thus $1\,J = 1\,N \times 1\,m$

(ii) When does a force do work? Explain.

Ans: Work is said to be done when a force acts on a body and moves it in the direction of the force.

Greater is the force acting on a body and longer is the distance moved by it, larger would be the work done. Mathematically, Work is a product of force F and displacement S in the direction of force. Thus

$\text{Work done} = \text{Force} \times \text{displacement}$

or $W = FS$ ..... (i)

If the force is unbalanced, it causes acceleration. This involves doing work to move it in a certain direction.

(iii) Define energy, give two types of mechanical energy.

Ans: Energy: A body possesses energy if it is capable to do work.

Types of mechanical energy:

Mechanical energy possessed by a body is of two types: kinetic energy and potential energy.

(iv) A man has pulled a cart through 35 m applying a force of 300 N. Find the work done by the man.

Solution: Distance = S = 3.5 ⟹ Force = F = 300N ⟹ Work done = W = ?

$W = F \times S \Rightarrow W = 300 \times 35 \Rightarrow W = 10500\ J$

(v) Why do we need energy?

Ans: Need of energy:

The energy is an important and fundamental concept in science. It links almost all the natural phenomena. When we say that a body has energy, we mean that it has the ability to do work. Water running down the stream has the ability to do work, so it possesses energy. The energy of running water can be used to run water mills or water turbines.

Energy exists in various forms such as mechanical energy, heat energy, light energy, sound energy, electrical energy, chemical energy and nuclear energy etc. Energy can be transformed from one form into another.

(vi) What is meant by the efficiency of a system?

OR

Efficiency of a system is the ratio of required form of energy obtained from a system as output to the total energy given to it as input.

$$\text{Efficiency} = \frac{\text{required form of output}}{\text{total input energy}} \quad \ldots\ldots \text{(i)}$$

$$\text{Or} \quad \%\text{ Efficiency} = \frac{\text{required form of output}}{\text{total input energy}} \times 100 \quad \ldots\ldots \text{(ii)}$$

(vii) Explain potential energy and derive its relation.

Ans: Potential Energy:

The energy possessed by a body due to its position is known as its potential energy.

Derivation of P.E:

Let a body of mass m be raised up through height h from the ground. The body will acquire potential energy equal to the work done in lifting it to height h.

Thus Potential energy $P.E = F \times h = w \times h$

(Here weight of the body = $w = mg$)

$\therefore$ $P.E. = wh = mgh$ ..... (i)

(viii) What is meant by the term power?

Ans: Power:

Power is defined as the rate of doing work.

Mathematically, $\text{Power} = P = \frac{\text{Work done}}{\text{Time taken}} \Rightarrow \text{or} \quad P = \frac{W}{t}$ ..... (i)

Since work is a scalar quantity, therefore, power is also a scalar quantity.

Note: Bigger units of power are kilowatt (kW), megawatt (MW) etc.

1kW	=	1000W	=	10^3W
1MW	=	1000 000 W	=	10^6W
1 horsepower	=	1 hp	=	746 W

SECTION – C (Marks 15)

(Chapter 6)

Q.3 Attempt any FIVE parts from the following. All parts carry equal marks. (5 × 3 = 15)

(i) Define watt.

Ans: Unit of power: SI unit of power is watt (W). It is defined as

Watt: The power of a body is one watt if it does work at the rate of 1 joule per second (1 Js^{-1}).

(ii) A block weighing 20 N is lifted 6 m vertically upward. Calculate the potential energy stored in it.

Solution: Weight of the block = w = 20N $\Rightarrow$ Height = h = 6m

Potential energy P.E. = ? $\Rightarrow$ P.E. = mgh

We know that $w = mg$

$P.E. = (mg) \times h \Rightarrow$ Thus P.E. = (2 × 10) × 6 = 120 J

(iii) A crate is moved by pulling the rope attached to it. It moves 10 m on a straight horizontal road by a force of 100 N. How much work will be done if;

1. The rope is parallel to the road.

Solution: Force = 100 N $\Rightarrow$ Distance = S = 10 m $\Rightarrow$ Work = W = ?

$W = F \times S \Rightarrow W = 100 \times 10 = 1000$ J

2. The rope is making an angle of 30° with the road.

Solution: Force = 100 N $\Rightarrow$ Distance = S = 10 m $\Rightarrow$ $\theta = 30°$

(iv) Differentiate energy resources as renewable and non-renewable resources of energy with examples of each?

Ans: Renewable resources of energy:

Renewable sources of energy are those which can be reused. They do not get extinguished. They are environmentally friendly they do not cause pollution.

Examples: Solar energy, wind energy and tidal energy

Non-renewable resources of energy:

Non-renewable sources of energy are those which cannot be reused. They get extinguished. They cause pollution and are environmentally harmful.

Examples: Plastic, wood, petroleum, oil, etc.

(v) How can you find the efficiency of a system?

Ans: Efficiency $= \frac{\text{required form of output}}{\text{total input energy}}$ ..... (i)

Or % Efficiency $= \frac{\text{required form of output}}{\text{total input energy}} \times 100$ ..... (ii)

(vi) State mass energy equation $E = mc^2$.

Ans: Mass-energy equation:

Einstein predicted the interconversion of matter and energy. According to him, a loss in the mass of a body provides a lot of energy. This happens in nuclear reactions. The relation between mass m and energy E is given by Einstein's mass-energy equation.

$$E = mc^2 \quad \text{..... (i)}$$

Here c is the speed of light ($3 \times 10^8\ ms^{-1}$) The above equation shows that tremendous amount of energy can be obtained from small quantity of matter.

(vii) A man pulls a block with a force of 300 N through 50 m in 60 s. Find the power used by him to pull the block.

Solution: Force = F = 300N $\Rightarrow$ Distance = S = 50m $\Rightarrow$ Time = t = 60s

Power = P = ? Power $= \frac{work}{time} = \frac{W}{t} = \frac{F \times S}{t} \Rightarrow P = \frac{300 \times 50}{60} = 5 \times 50 = 250\ W$

SECTION – D (Marks 20)

Note: Attempt any TWO questions. All questions carry equal marks. **(2 × 10 = 20)**

Q.4 (a) Define K.E. and derive its relation.

Ans: See Page # 123, Q3. (vi) From FBISE Past Paper (2020).

(b) A 500 g stone is thrown up with a velocity of 15 ms^{-1}. Find its

(i) P.E. at its maximum height **(ii) K.E. when it hits the ground**

Solution: Mass of stone = m = 500 g = $\frac{500}{1000}$ kg = 0.5 kg $\Rightarrow$ Velocity = v = 15 ms^{-1}

(i) Potential energy P.E. = ? (ii) Kinetic energy K.E.= ?

(i) Loss of K.E. = Gain in P.E. $\Rightarrow$ $\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 = mgh$

As velocity of the stone at maximum height becomes zero, therefore, $v_f = 0$

$$\frac{1}{2} \times 0.5 \times (0) - \frac{1}{2} \times 0.5 \times (15)^2 = mgh \Rightarrow -\frac{1}{2} \times 0.5 \times 225 = mgh$$

$$-56.25 = mgh \Rightarrow mgh = -56.25J$$

Since energy is always positive, therefore P.E. = 56.25 J

(ii) K.E. $= \frac{1}{2}mv^2 \Rightarrow$ K.E. $= \frac{1}{2} \times 0.5 \times (15)^2 = \frac{1}{2} \times 0.5 \times 225 = 56.25\ J$

Q.5 (a) What is meant by the efficiency of a system?

Ans: Efficiency:

The ratio of the useful work done by a device or machine to the total energy taken up by it is called its

$$\text{Efficiency} = \frac{\text{required form of output}}{\text{total input energy}} \quad \ldots\ldots\ldots (i)$$

$$\text{Or} \quad \% \text{ Efficiency} = \frac{\text{required form of output}}{\text{total input energy}} \times 100 \quad \ldots\ldots\ldots (ii)$$

Ideal system/Ideal machine:

An ideal system is that which gives an output equal to the total energy used by it. In other words, its efficiency is 100 %.

(b) A car weighing 12 kN has speed of 20 ms^{-1}. Find its kinetic energy.

Solution: Weight of the car $w = 12kN = 12 \times 1000N = 12000N$

Speed of the car $v = 20ms^{-1}$

Kinetic energy K.E. = ?

$$K.E. = \frac{1}{2}mv^2 \implies w = mg \quad \text{or} \quad m = \frac{w}{g}$$

$$\therefore \quad m = \frac{12000}{10} = \frac{12000}{10} = 1200 \text{ kg}$$

Thus $K.E. = \frac{1}{2} \times 1200 \times (20)^2 = 600 \times 400 = 240000 \text{ J} = 240 \times 10^3 \text{ J} \implies = 240 \text{ kJ}$

Q.6 On reaching the top of a slope 6 m high from its bottom, a cyclist has a speed of 1.5 ms^{-1}. Find the kinetic energy and the potential energy of the cyclist. The mass of the cyclist and his bicycle is 40kg.

Solution: Height of the slope = h = 6 m

Speed of the cyclist = $v = 1.5 ms^{-1}$

Mass of cyclist and the bicycle = m = 40 kg

(i) Kinetic energy K.E. = ?

(ii) Potential energy P.E. = ?

(i) $K.E. = \frac{1}{2}mv^2$

$$K.E. = \frac{1}{2} \times 40 \times (1.5)^2 = \frac{1}{2} \times 40 \times 2.25 = 45 \text{ J}$$

(ii) $P.E. = mgh$

$$P.E. = 40 \times 10 \times 6 = 2400 \text{ J}$$

UNIT 7: PROPERTIES OF MATTER

Theory Topics:

7.2: Density,
7.3: Pressure,
7.5: Pressure in Liquid
{Pascal's Law, Application of Pascal's Law (Hydraulic Press Only)}
7.6: Archimede's Principle,
7.7: Principle of Floatation
7.8: Elasticity,
7.9: Hook's Law

NOTE:

- All mini exercises, quick quiz and side information are excluded.
- Only topic based related MCQs, Short and Long Questions and numerical are included.

GUESS PAPER & MODEL PAPER # 7
BASED ON UNIT # 7 (Reduced Syllabus)
PROPERTIES OF MATTER

SECTION-A

Time allowed: 20 Minutes **Marks: 12**

Note: Section-A is compulsory. All parts of this section are to be answered on the question paper itself. It should be completed in the first 20 minutes and handed over to the Centre Superintendent. Deleting/overwriting is not allowed. Do not use lead pencil.

Q.1 Encircle the correct option i.e. A / B / C / D. All parts carry equal marks.

i. A machine which works on Pascal's law is known as
A. Vernier caliper B. Hydraulic press
C. barometer D. screw gauge

ii. Which of the substances is the lightest one?
A copper B. mercury C. aluminum D. lead

iii. SI unit of pressure is pascal, which is equal to:
A. $10^4\ Nm^{-2}$ B. $1\ Nm^{-2}$ C. $10^2\ Nm^{-2}$ D. $10^3\ Nm^{-2}$

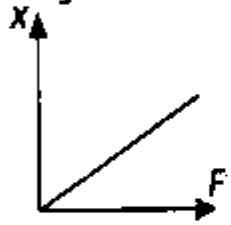
iv. Mass per unit volume is called
A. resistance B. volume C. density D. weight

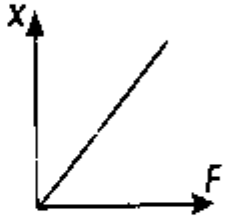
v. According to Archimedes upthrust is equal to:
A. weight of displaced liquid B. volume of displaced liquid
C. mass of displaced liquid D. none of these

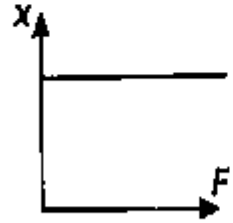
vii. **According to Hooke's law**

A. stress × strain = constant
B. stress / strain = constant
C. strain / stress = constant
D. stress = strain

The following force-extension graphs of a spring are drawn on the same scale. Answer the questions given below from (viii) to (x).

A.


B.


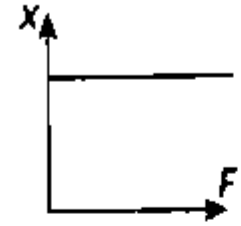
C.


D.


viii. **Which graph does not obey Hooke's law?**

A.


B.

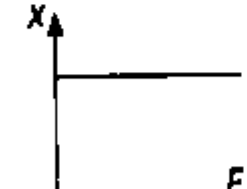

C.


D.


ix. **Which graph gives the smallest value of spring constant?**

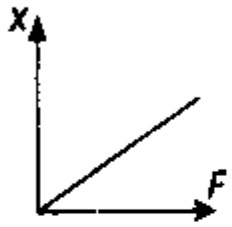
A.


B.

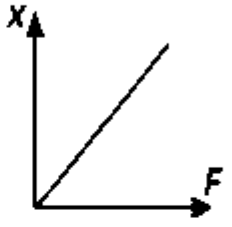

C.


D.

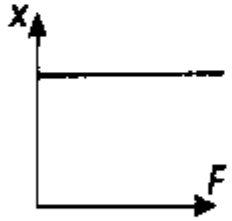

x. Which graph gives the largest value of spring constant?



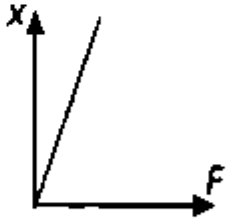
A.



B



C.



D

xi. At sea level, the atmospheric pressure is about _____
A. 101.300 Nm^{-2} B. 101.200 Nm^{-2} C. 101.100 Nm^{-2} D. 101.400 Nm^{-2}

xii. A wooden block measuring 40 cm × 10 cm × 5 cm has a mass 850g. The density of wood is _____.
A. 423 kgm^{-3} B. 425 kgm^{-3} C. 424 kgm^{-3} D. 426 kgm^{-3}

Time Allowed: 2:40 Minutes **Total Marks: 53**

Note: Answer any six parts from Section 'B' and attempt any five parts from Section-C. Attempt any two questions from Section 'D' on the separately provided answer book. Use supplementary answer sheet i.e. Sheet-B if required. Write your answers neatly and legibly

SECTION – B (Marks 18)

Q.2 Attempt any SIX parts from the following. All parts carry equal marks. (6 × 3 = 18)

(i) What is upthrust? Explain the principle of floatation.
(ii) Differentiate between stress and strain?
(iii) Explain how a wooden block, ships and boats moves up the water surface.
(iv) A cube of glass of 5 cm side and mass 306 g, has a cavity inside it. If the density of glass is 2.55 gcm^{-3}. Find the volume of the cavity.
(v) What is meant by elasticity?
(vi) A steel wire of cross-sectional area 2×10^{-5} m^2 is stretched through 2 mm by a force of 4000 N. Find the Young's modulus of the wire. The length of the wire is 2 m.
(vii) Explain the working of hydraulic press.
(viii) Calculate the density of 5 liter of water?

SECTION – C (Marks 15)

Q.3 Attempt any FIVE parts from the following. All parts carry equal marks. (5 × 3 = 15)

(i) What is Hooke's law?
(ii) Explain how a submarine moves up the water surface and down into water.
(iii) State relation for pressure beneath a liquid surface to depth and to density?
OR Prove that ($P = \rho gh$).
(iv) A student presses her palm by her thumb with a force of 75 N. How much would be the pressure under her thumb having contact area 1.5 cm^2?

SECTION – D (Marks 20)

Note: Attempt any TWO questions. All questions carry equal marks. (2 × 10 = 20)

Q.4 (a) State Archimedes principle.

(b) A uniform rectangular block of wood 20 cm × 7.5 cm × 7.5 cm and of mass 1000 g stands on a horizontal surface with its longest edge vertical. Find

(i) the pressure exerted by the block on the surface

(ii) density of the wood.

Q.5 (a) State Pascal's law.

(b) The diameter of the piston of a hydraulic press is 30 cm. How much force is required to lift a car weighing 20000 N on its piston if the diameter of the piston of the pump is 3 cm?

Q.6 What do you know about Young's modulus? How would you determine young's modulus of an object?

(b) Calculate the volume of the following objects:

(i) An iron sphere of mass 5 kg, the density of iron is 8200 kgm ^{3}.

(II) 200 g of lead shot having density 11300 kgm^{-3}

(iii) A gold bar of mass 0.2 kg. The density of gold is 19300 kgm^{-3}.

SOLUTION OF GUESS PAPER & MODEL PAPER # 7
(Reduced Syllabus)

SECTION- A (MCQs)

i. B	ii. C	iii. B	iv. C	v. A	vi. C
vii. B	viii. C	ix. D	x. A	xi. A	xii. B

SECTION – B (Marks 18)

Q.2 Attempt any SIX parts from the following. All parts carry equal marks. (6 × 3 = 18)

(I) What is upthrust? Explain the principle of floatation.

Ans: Upthrust:

Upthrust is the force that pushes an object up and makes it seem to lose weight in a fluid. (Remember, a fluid means a liquid or a gas).

The upthrust, or buoyancy, keeps ships afloat. The upthrust, or buoyancy, keeps swimmers on top of the water.

Principle of floatation:

An object sinks if its weight is greater than the upthrust acting on it. An object floats if its weight is equal or less than the upthrust. When an object floats in a fluid, the upthrust acting on it is equal to the weight of the object.

In case of floating object, the object may be partially immersed. The upthrust is always equal to the weight of the fluid displaced by the object. This is the principle of floatation It states that:

A floating object displaces a fluid having weight equal to the weight of the object.

Archimedes principle is applicable on liquids as well as gases.

(ii) Differentiate between stress and strain?

Ans: Stress: The force acting on unit area at the surface of a body is called stress.

Thus **Stress** = $\frac{\text{Force}}{\text{Area}}$

Unit: In SI, the unit of stress is newton per square metre (Nm^{-2}).

If stress produces a change in the length of an object then the strain is called tensile strain.

$$\text{Tensile strain} = \frac{\text{change in length}}{\text{original length}}$$

Strain has no units as it is simply a ratio between two similar quantities.

(iii) Explain how a wooden block, ships and boats moves up the water surface.

Ans: A wooden block floats on water. It is because the weight of an equal volume of water is greater than the weight of the block. According to the principle of floatation, a body floats if it displaces water equal to the weight of the body when it is partially or completely immersed in water.

Ships and boats are designed on the same principle of floatation. They carry passengers and goods over water. It would sink in water if its weight including the weight of its passengers and goods becomes greater than the upthrust of water.

(iv) A cube of glass of 5 cm side and mass 306 g, has a cavity inside it. If the density of glass is 2.55 gcm^{-3}. Find the volume of the cavity.

Solution: Side of the cube = 7.5cm $\Rightarrow$ Mass of the cube = m = 306g

Density of glass = ρ = 2.55gcm^{-3} $\Rightarrow$ Volume of the cavity = V = ?

Volume of the whole cube = 5 cm × 5 cm × 5 cm = 125 cm^3

$$\text{Volume of the glass} = \frac{Mass}{Density} = \frac{306}{2.55} = 120 \text{ cm}^3$$

Volume of the cavity = 125 cm^3 – 120 cm^3 = 5cm^3

(v) What is meant by elasticity?

Ans: Elasticity:

The property of a body to restore its original size and shape as the deforming force ceases to act is called elasticity.

Due to elasticity we can determine the strength of a material and the deformation produce under the action of a force.

(vi) A steel wire of cross-sectional area 2 × 10-5 m2 is stretched through 2 mm by a force of 4000 N. Find the Young's modulus of the wire. The length of the wire is 2 m.

Solution: Cross-sectional area = A = 2×10^{-5} m^2

Extension = ΔL = 2 mm = $2 \times \frac{1}{1000}$ m = 0.002 m

Force = F = 4000N $\Rightarrow$ Length of the wire = L = 1m $\Rightarrow$ Young's modulus = Y = ?

$$Y = \frac{FL}{A\Delta L} \Rightarrow = \frac{4000 \times 2}{2 \times 10^{-5} \times 0.002} = \frac{8000}{0.004 \times 10^{-5}}$$

$$Y = \frac{8000}{0.004} \times 10^{-5} \Rightarrow Y = 2{,}000{,}000 \times 10^{-5} = 2 \times 10^{11} \text{ Nm}^{-2}$$

(vii) Explain the working of hydraulic press.

Ans: Hydraulic Press:

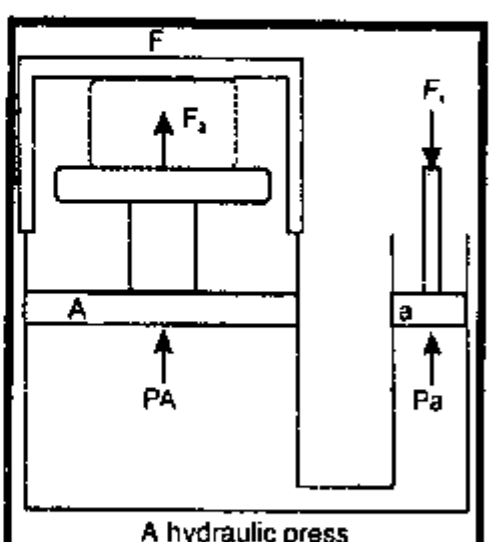
Hydraulic press is a machine which works on Pascal's law. It consists of two cylinders of different cross-sectional areas. They are fitted with pistons of cross-sectional areas a and *A*

The object to be compressed is placed over the piston of large cross-sectional area *A*. The force F_1 is applied on the piston of small cross-sectional area a. The pressure *P* produced by small piston is transmitted equally to the large piston and a force F_2 acts on A which is much larger than F_1.

Pressure on piston of small area a is given by

$$P = \frac{F_1}{a}$$

Apply Pascal's law, the pressure on large piston of area A



A hydraulic press

(b) The diameter of the piston of a hydraulic press is 30 cm. How much force is required to lift a car weighing 20000 N on its piston if the diameter of the piston of the pump is 3 cm?

Solution:

Diameter of the piston = D = 30 cm

Radius of the piston = $R = \frac{D}{2} = \frac{30\,cm}{2} = 15$ cm $= \frac{15}{100}$ m = 0.15 m

Area of the piston = $A = 2\pi R^2 = 2 \times 3.14 \times (0.15)^2$

$A = 0.1413 m^2$

Weight of the car $w = F_2 = 20000N$

Diameter of the piston $d = 3cm$

Radius of the piston $r = \frac{d}{2} = \frac{3}{2} = 1.5\ cm = \frac{15}{1000}\ m = 0.015m$

Area of the piston $a = 2\pi r^2 \implies a = 2 \times 3.14 \times (0.015m)^2$

$a = 1.1413 \times 10^{-3} m^2$

Force = F_1 = ?

$$\frac{F_1}{a} = \frac{F_2}{A} \implies F_1 = F_2 \times \frac{a}{A} \implies F_1 = 20000N \times \frac{1.413 \times 10^{-3}}{0.1413} = 20000N \times 0.01$$

$F_1 = 200$ N

Q.6 (a) What do you know about Young's modulus? How would you determine young's modulus of an object?

Ans: Young's modulus:

The ratio of stress to tensile strain is called Young's modulus.

Determination of young's modulus:

Consider a long bar of length L_o and cross-sectional area A. Let an external force F equal to the weight w stretches it such that the stretched length becomes L According to Hooke's law, the ratio of this stress to tensile strain is constant within the elastic limit of the body.

Young's modulus $Y = \frac{\text{Stress}}{\text{Tensile stain}}$

Let ΔL be the change in length of the rod, then

$$\Delta L = L - L_O$$

Since $\text{Stress} = \frac{\text{Force}}{\text{Area}} = \frac{F}{A}$

and $\text{Tensile strain} = \frac{L - L_O}{L_O} = \frac{\Delta L}{L_O}$

As $Y = \frac{\text{Stress}}{\text{Tensile strain}} = \frac{F}{A} \times \frac{L_O}{\Delta L} \implies \therefore Y = \frac{F L_O}{A \Delta L}$

Unit: SI unit of Young's modulus is newton per square metre (Nm^{-2}).

(b) Calculate the volume of the following objects:

(i) An iron sphere of mass 5 kg, the density of iron is 8200 kgm^{-3}.

(ii) 200 g of lead shot having density 11300 kgm^{-3}

(iii) A gold bar of mass 0.2 kg. The density of gold is 19300 kgm^{-3}.

Solution: Mass of iron sphere = m = 5 kg $\implies$ Density of iron $= \rho = 8200\ kgm^{-3}$

Volume of iron sphere = V = ? $\implies$ Volume $= \frac{Mass}{Density}$

Volume $= \frac{5}{8200} = 0.00060975 = 6.0975 \times 10^{-4} = 6.1 \times 10^{-4} m^3$

(ii) Mass of lead shot = m = 200 g $= \frac{200}{\quad}$ kg = 0.2kg $\implies$ Density of lead = ρ = 11300 kgm^{-3}

$V = \frac{0.2}{11300} = 0.000017699 \implies V = 1.7699 \times 10^{-5}\ m^3 = 1.77 \times 10^{-5}\ m^3$

(iii) Mass of gold bar = m = 0.2 kg

Density of gold = ρ = 19300 kgm^{-3} $\implies$ Volume of gold bar = V = ?

$Volume = \frac{Mass}{Density} \implies V = \frac{0.2}{19300} = 0.000010362 = 1.0362 \times 10^{-5} \implies V = 1.04 \times 10^{-5}\ m^3$

IMPORTANT QUESTIONS

Q1. Is an iron object heavier than that of wood? OR
Why is 1 cm cubed of wood lighter than 1 cm cubed of iron?

Ans: Because centimeters cubed is a unit of volume, not weight. The two might take up the same amount of space, but iron is much more dense and as such weighs more.

$$\text{Density} = \frac{\text{mass of a substance}}{\text{volume of suthat bstance}} \qquad OR \qquad D = \frac{m}{V}$$

Q2. Why does a piece of stone sink in water but a ship with a huge weight floats?

Ans: It is due to Archimedes principle. Density of ship is less it displace more liquid, experience more upward thrust and floats where as density of stone is more, it displace less liquid experience less upward thrust and sinks.

Q3. Take a rubber band. Construct a balance of your own using a rubber band. Check its accuracy by weighing various objects.

Ans: We know that the length of a rubber band increases on stretching it. Similarly, the pointer of a spring balance is lowered when a body is suspended from it. It is because the length of the spring inside the balance increases depending upon the weight of the suspended body.

A rubber band scale will be fairly accurate, but only for a short time. Eventually the rubber band will begin to stretch and wear out. A better scale may be made by substituting a metal spring for the rubber band. Such a scale will be just as accurate, and because the spring is made of metal, it will last much longer.

Q4. A wooden block measuring 40 cm × 10 cm × 5 cm has a mass 850g. Find the density of wood?

Solution: Volume of wooden block = V = 40cm × 10cm × 5cm = 2000 cm^3

$$= 2000 \times \frac{1}{100} \times \frac{1}{100} \times \frac{1}{100}\ m^3 = 0.002\ m^3$$

Mass = m = 850g = $\frac{850}{1000}$ kg = 0.85 kg $\implies$ Density of wood = ρ = ?

$$Density = \frac{Mass}{Volume} = \frac{0.85\ kg}{0.002\ m^3} = 425\ kgm^{-3}$$

Q5. How much would be the volume of ice formed by freezing 1 litre of water?

Solution: Voume of water = 1 litre $\implies$ Volume of ice = ?

1 litre of water = 1 kg mass and density = 1000 kgm^{-3}

Since density of ice is 0.92 times of the liquid water ; Density of ice = 1000 × 0.92 = 920 kgm^{-3}

$$Volume\ of\ ice = \frac{mass}{}$$

Q6. The head of a pin is a square of side 10 mm. Find the pressure on it due to a force of 20 N.

Solution: Area of head of a pin A = 10mm × 10mm = $\frac{10}{10}$ cm × $\frac{10}{10}$ cm

= 1cm × 1cm = $\frac{1}{100}$ m × $\frac{1}{100}$ m = 10^{-4} m^2

Force = F = 20N $\Longrightarrow$ Pressure = P = ?

$P = \frac{F}{A} \Longrightarrow P = \frac{20}{1 \times 10^{-4}} = 2 \times 10^5$ Nm^{-2}

Q7. An object has weight 18 N in air. Its weight is found to be 11.4 N when immersed in water. Calculate its density. Can you guess the material of the object?

Solution: Weight of object in air = w_1 = 18N

Weight of object immersed in water = w_2 = 11.4N

Density of water = ρ = 1000 kgm^{-3}

(i) Density of the object = D = ?

(ii) Nature of the material = ?

(i) $D = \frac{w_1}{w_1 - w_2} \times \rho$

$D = \frac{18}{18-11.4} \times 1000 = \frac{18}{6.6} \times 1000 = 2.727 \times 10^3 = 2727$ kgm^{-3}

(ii) The density of aluminum is 2700 kgm^{-3}, the above calculated value of density is 2727 kgm^{-3} nearest to the density of aluminum it, so the material of the object is aluminum.

Q10. A solid block of wood of density 0.6 gcm^{-3} weighs 3.06 N in air. Determine (a) volume of the block (b) the volume of the block immersed when placed freely in a liquid of density 0.9 g cm^{-3}?

Solution: Density of wood = D = 0.6 gcm^{-3}

Weight of wooden block = w = 3.06N

Since w = mg or $m = \frac{w}{g} = \frac{3.06}{10}$ = 0.306kg = 306g

Density of liquid D = 0.9 gcm^{-3}

(i) Volume of the block V = ?

(ii) Volume of the block immersed in a liquid V = ?

Density = $\frac{Mass}{Volume}$ or Volume = $\frac{Mass}{Density}$

$\Longrightarrow$ $V = \frac{306g}{0.6gcm^{-3}} = 510$ cm^3

(b) Volume = $\frac{Mass}{Density}$

$V = \frac{306\ g}{0.9\ gcm^{-3}}$

V = 340 cm^3

UNIT 8: THERMAL PROPERTIES

8.3: Specific heat capacity, importance of large specific Heat capacity of water, heat capacity

8.8: Thermal expansion (linear and volume expansion) consequences and applications of thermal expansion only)
(Table: 8.1, 8.3, 8.4 included)

NOTE:

- All mini exercises, quick quiz and side information are excluded.
- Only topic based related MCQs, Short and Long Questions and numerical are included.

GUESS PAPER & MODEL PAPER # 8
BASED ON UNIT # 8 (Reduced Syllabus)
THERMAL PROPERTIES OF MATTER

SECTION-A

Time allowed: 20 Minutes **Marks: 12**

Note: Section-A is compulsory. All parts of this section are to be answered on the question paper itself. It should be completed in the first 20 minutes and handed over to the Centre Superintendent. Deleting/overwriting is not allowed. Do not use lead pencil.

Q.1 Encircle the correct option i.e. A / B / C / D. All parts carry equal marks.

i. The amount of heat required to raise the temperature of 1 kg mass of that substance through 1K is called its
A. specific energy B specific heat
C. specific stress D. specific density

ii. An increase in breadth, length, and thickness of a substance is due to
A. fusion B. thermal expansion
C. stress D. boiling

iii. The fraction change in the volume per kelvin change in temperature is equal to
A. coefficient of linear thermal expansion
B. temperature coefficient of volume expansion
C. pressure expansion D. coefficient of contraction

iv. Which of the following material has large specific heat?
A. copper B. ice C water D. mercury

v. Which of the following material has large value of temperature coefficient of linear expansion?
A. aluminum B. gold C brass D. steel

vi. What will be the value of β for a solid for which α has a value of $2 \times 10^{-5} K^{-1}$?
A. $2 \times 10^{-5} K^{-1}$ B. $6 \times 10^{-5} K^{-1}$ C $8 \times 10^{-15} K^{-1}$ D. $8 \times 10^{-5} K^{-1}$

viii. Wires on electric poles are given some sag to prevent breaking in
A. winter B. rainy season C. hot season D. wind

ix. Thermal volume expansion of liquid has
A. 3 types B. 2 types C. 4 types D. 5 types

x. When the volume of solid changes with the change in temperature then it is called
A. volume thermal contraction B. double volume
C. volume thermal expansion C. volume constant

xi. Specific heat of iron is _____.
A. 470 $Jkg^{-1}K^{-1}$ B. 480 $Jkg^{-1}K^{-1}$ C. 475 $Jkg^{-1}K^{-1}$ D. 485 $Jkg^{-1}K^{-1}$

xii. The fractional increase in length per Kalvin rise in temperature is
A. linear expansion B. coefficient of linear expansion
C. volume expansion D. coefficient of volume expansion

Time Allowed: 2:40 Minutes **Total Marks: 53**

Note: Answer any six parts from Section 'B' and attempt any five parts from Section-C. Attempt any two questions from Section 'D' on the separately provided answer book. Use supplementary answer sheet i.e. Sheet-B if required. Write your answers neatly and legibly

SECTION – B (Marks 18)

Q.2 Attempt any SIX parts from the following. All parts carry equal marks. (6 × 3 = 18)

(i) How specific heat differs from heat capacity?
(ii) Define thermal expansion.
(iii) Why gaps are left in railway tracks?
(iv) Why gaps are left in bridges with rollers?
(v) How much heat is required to increase the temperature of 0.5 kg of water from 10 °C to 65°C?
(vi) Calculate the increase in the length of an aluminum bar 2 m long when heated from 0°C to 20 °C. If the thermal coefficient of linear expansion of aluminum is $2.5 \times 10^{-5} K^{-1}$.
(vii) A balloon contains 1.2 m^3 air at 15 °C. Find its volume at 40 °C. Thermal coefficient of volume expansion of air is $3.67 \times 10^{-3} K^{-1}$.
(viii) Define specific heat.

SECTION – C (Marks 15)

Q.3 Attempt any FIVE parts from the following. All parts carry equal marks. (5 × 3 = 15)

(i) Define heat capacity. How would you find the heat capacity of a solid?
(ii) Why the coefficient of volume expansion of liquids is greater than solids?
(iii) Illustrate the specific heat of some common substances.
(iv) Gives coefficient of linear thermal expansion of some common solids.
(v) Give the values of β for different substances?
(vi) List the application of thermal expansion?
(vii) Why overhead transmission lines (wires on electric poles) are also given a certain amount of sag?

SECTION – D (Marks 20)

Note: Attempt any TWO questions. All questions carry equal marks. (2 × 10 = 20)

Q.4 Define specific heat. How would you find the specific heat of a solid? Also Describe the

SOLUTION OF GUESS PAPER & MODEL PAPER # 8
(Reduced Syllabus)

SECTION- A (MCQs)

i. B	ii. B	iii. B	iv. C	v. A	vi. B
vii. D	viii. A	ix. B	x. C	xi. A	xii. B

SECTION – B (Marks 18)

Q.2 Attempt any SIX parts from the following. All parts carry equal marks. (6 × 3 = 18)

(i) How specific heat differs from heat capacity?

Ans:

Specific Heat	Heat Capacity
Specific heat of a substance is the amount of heat required to raise the temperature of 1kg mass of that substance through 1K.	Heat capacity of a body is the quantity of thermal energy absorbed by it for one kelvin (1K) increase in its temperature
Specific heat can be found out by the relation. $C = \frac{\Delta Q}{m\Delta T}$	Heat capacity can be found out by the relation. Heat capacity = mc
SI unit of specific heat is $Jkg^{-1}K^{-1}$.	Unit of heat capacity is JK^{-1}.

(ii) Define thermal expansion.

Ans: Thermal expansion:

Thermal expansion is the tendency of matter to change in volume in response to a change in temperature.

On heating, the amplitude of vibration of the atoms or molecules of an object increases. They push one another farther away as the amplitude of vibration increases. Thermal expansion results an increase in length, breadth and thickness of a substance.

(iii) Why gaps are left in railway tracks?

Ans: Gapes are left in railway tracks to compensates thermal expansion during hot season. Railway tracks buckled on a hot summer day due to expansion if gaps are not left between sections.

(iv) Why gaps are left in bridges with rollers?

Ans: Bridges made of steel girders also expand during the day and contract during night. They will bend if their ends are fixed To allow thermal expansion, one end is fixed while the other end of the girder rests on rollers in the gap left for expansion.

(v) How much heat is required to increase the temperature of 0.5 kg of water from 10 °C to 65°C?

Solution: Mass of water = m = 0.5 kg

Initial temperature = T_1 = 10°C = 10 + 273 = 283 K

Final temperature = T_2 = 65°C = 65 + 273 = 338 K

Change in temperature = $\Delta T = T_2 - T_1$ = 338 - 283 = 55K

Heat = ΔQ = ? $\Rightarrow$ $\Delta Q = mc\Delta T$ $\Rightarrow$ $\Delta Q = 0.5 \times 2400 \times 55$ $\Rightarrow$ ΔQ = 115500 J

(vi) Calculate the increase in the length of an aluminum bar 2 m long when heated from 0°C to 20 °C. If the thermal coefficient of linear expansion of aluminum is $2.5 \times 10^{-5} K^{-1}$.

Solution: Original length of rod = L_o = 2 m

Initial temperature = T_0 = 0 °C = 0 + 273 = 273 K

Final temperature = T = 20 °C = 20 + 273 = 293 K

Change in temperature = $\Delta T = T - T_0$ = 293 – 273 = 20 K

(vii) A balloon contains 1.2 m^3 air at 15 °C. Find its volume at 40 °C. Thermal coefficient of volume expansion of air is $3.67 \times 10^{-3} K^{-1}$.

Solution: Original volume = $V_o = 1.2\ m^3$
Initial temperature = $T_o = 15\ °C = 15 + 273 = 288\ K$
Final temperature = $T = 40\ °C = 40 + 273 = 313\ K$
Change in temperature = $\Delta T = T - T_o = 313 - 288 = 25K$
Coefficient of volume expansion of air $\beta = 3.67 \times 10^{-3}\ K^{-1}$
Volume = $V = ?$ $\Rightarrow$ $V = V_o(1 + \beta \Delta T)$
$V = 1.2(1 + 3.67 \times 10^{-3} \times 25) = 1.2(1 + 91.75 \times 10^{-3})$
$= 1.2\ (1 + 0.09175) = 1.2 \times 1.09175$ $\Rightarrow$ $V = 1.3\ m^3$
$T_3 = 16.2\ °C$

(viii) Define specific heat.

Ans: Specific heat:

Specific heat of a substance is the amount of heat required to raise the temperature of 1 kg mass of that substance through 1K.

It has been observed that the quantity of heat ΔQ required to raise the temperature ΔT of a body is proportional to the mass m of the body. Thus

$$\Delta Q \propto m \Delta T$$

or $$\Delta Q = c\, m \Delta T \quad \ldots\ldots\ldots\ldots \text{(i)}$$

Here ΔQ is the amount of heat absorbed by the body and c is the constant of proportionality called the specific heat capacity or simply specific heat.

Mathematically,

$$c = \frac{\Delta Q}{m \Delta T} \quad \ldots\ldots\ldots\ldots \text{(ii)}$$

Unit of specific heat: SI unit of specific heat is $Jkg^{-1}K^{-1}$.

SECTION – C (Marks 15)

Q.3 Attempt any FIVE parts from the following. All parts carry equal marks. (5 × 3 = 15)

(i) Define heat capacity. How would you find the heat capacity of a solid?

Ans: Heat capacity:

Heat capacity of a body is the quantity of thermal energy absorbed by it for one kelvin (1 K) increase in its temperature.

If the temperature of a body increases through ΔT on adding ΔQ amount of heat, then its heat capacity will be $\frac{\Delta Q}{\Delta T}$. Putting the value of ΔQ, we get

$$\text{Heat capacity} = \frac{\Delta Q}{\Delta T} = \frac{m c \Delta T}{\Delta T}$$

$$\therefore \quad \text{Heat capacity} = mc \quad \ldots\ldots\ldots\ldots \text{(i)}$$

Equation (i) shows that heat capacity of a body is equal to the product of its mass of the body and its specific heat capacity.

For example, heat capacity of 5 kg of water is ($5\ kg \times 4200\ Jkg^{-1}K^{-1}$) $21000\ JK^{-1}$. That is; 5 kg of water needs 21000 joules of heat for every 1 K rise in its temperature. Thus, larger is the quantity of a substance, larger will be its heat capacity.

(ii) Why the coefficient of volume expansion of liquids is greater than solids?

Ans: The molecules of liquids are free to move in all directions within the liquid. On heating a liquid, the average amplitude of vibration of its molecules increases. The molecules push each other and need more space to occupy. This accounts for the expansion of the liquid when heated. The thermal expansion in liquids is greater than solids due to the weak forces between their molecules. Therefore, the coefficient of volume expansion of liquids is greater than solids.

(iii) Illustrate the specific heat of some common substances.

Ans: Specific heat of some common substances:

Substance	Specific heat ($Jkg^{-1}K^{-1}$)	Substance	Specific heat ($Jkg^{-1}K^{-1}$)
Alcohol	2500.0	Iron	470.0
Aluminum	903.0	Lead	128.0
Bricks	900.0	Mercury	138.6
Carbon	121.0	Sand	835.0
Clay	920.0	Silver	235.0
Copper	387.0	Soil (dry)	810.0
Ether	2010.0	Steam	2016.0
Glass	840.0	Tungsten	134.8
Gold	128.0	Turpentine	1760.3
Granite	790.0	Water	4200.0
Ice	2100.0	Zinc	385.0

(Iv) Gives coefficient of linear thermal expansion of some common solids.

Ans: Table gives coefficient of linear thermal expansion of some common solids.

Coefficient of linear thermal expansion (α) of some common solids	
Substance	$\alpha\,(K^{-1})$
Aluminum	2.4×10^{-5}
Brass	1.9×10^{-5}
Copper	1.7×10^{-5}
Steel	1.2×10^{-5}
Silver	1.93×10^{-5}
Gold	1.3×10^{-5}
Platinum	8.6×10^{-5}
Tungsten	0.4×10^{-5}
Glass (pyrex)	0.4×10^{-5}
Glass(ordinary)	0.9×10^{-5}
Concrete	1.2×10^{-5}

(v) Give the values of β for different substances?

Ans: Coefficient of volume expansion of various substances:

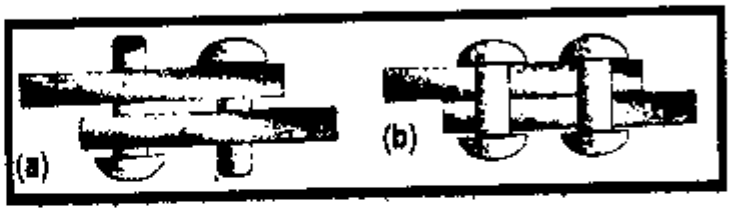
Substance	$\beta(K^{-1})$
Aluminum	7.2×10^{-5}
Brass	6.0×10^{-5}
Copper	5.1×10^{-5}
Steel	3.6×10^{-5}
Platinum	27.0×10^{-5}
Glass(ordinary)	2.7×10^{-5}
Glass(pyrex)	1.2×10^{-5}
Glycerine	53×10^{-5}
Mercury	18×10^{-5}
Water	21×10^{-5}
Air	3.67×10^{-3}
Carbon dioxide	3.72×10^{-3}

(vi) List the application of thermal expansion?

Ans: Application of thermal expansion:

i. In thermometers, thermal expansion is used in temperature measurements.

ii. To open the cap of a bottle that is tight enough, immerse it in hot water for a minute or so. Metal cap expands and becomes loose. It would now be easy to turn it to open.



iii. To join steel plates tightly together, red hot rivets are forced through holes in the plates. The end of hot rivet is then hammered. On cooling, the rivets contract and bring the plates tightly gripped.

iv. Iron rims are fixed on wooden wheels of carts. Iron rims are heated. Thermal expansion allows them to slip over the wooden wheel. Water is poured on it to cool. The rim contracts and becomes tight over the wheel.

(vii) Why overhead transmission lines (wires on electric poles) are also given a certain amount of sag?

Ans: Overhead transmission lines are also given a certain amount of sag so that they can contract in winter without snapping.

SECTION – D (Marks 20)

Note: Attempt any TWO questions. All questions carry equal marks. **(2 × 10 = 20)**

Q.4 Define specific heat. How would you find the specific heat of a solid? Also Describe the Importance of large specific heat capacity of water

Ans: Specific heat:

Specific heat of a substance is the amount of heat required to raise the temperature of 1 kg mass of that substance through 1K.

It has been observed that the quantity of heat ΔQ required to raise the temperature ΔT of a body is proportional to the mass m of the body. Thus

$$\Delta Q \propto m \Delta T$$

or $$\Delta Q = c m \Delta T \quad \ldots\ldots\ldots\ldots \text{(i)}$$

Here ΔQ is the amount of heat absorbed by the body and c is the constant of proportionality called the specific heat capacity or simply specific heat.

Mathematically,

$$c = \frac{\Delta Q}{m \Delta T} \quad \ldots\ldots\ldots\ldots \text{(ii)}$$

Unit of specific heat:

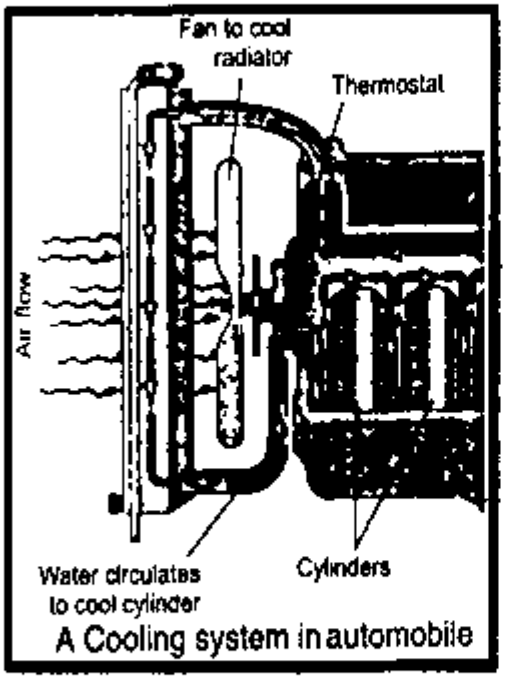
SI unit of specific heat is $Jkg^{-1}K^{-1}$.

Importance of large specific heat capacity of water:

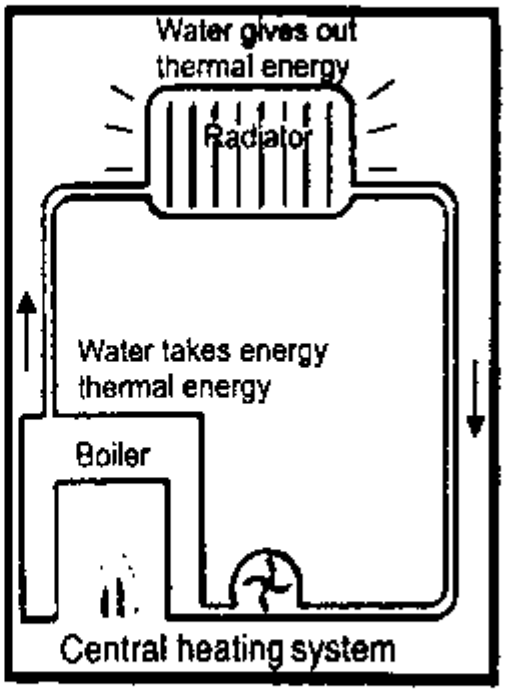
Specific heat of water is $4200\ Jkg^{-1}K^{-1}$ and that of dry soil is about $810\ Jkg^{-1}K^{-1}$. As a result the temperature of soil would increase five times more than the same mass of water by the same amount of heat. Thus, the temperature of land rises and falls more rapidly than that of the sea. Hence, the temperature variations from summer to winter are much smaller at places near the sea than land far away from the sea.

Storing and carrying thermal energy:

Water has a large specific heat capacity. For this reason, it is very useful in storing and carrying thermal energy due to its high specific heat capacity. The cooling system of automobiles uses water to carry away unwanted thermal energy. In an automobile, large amount of heat is produced by its engine due to which its temperature goes on increasing. The engine would cease unless it is not cooled down. Water circulating around the engine by arrows in maintains its temperature. Water absorbs unwanted thermal energy of the engine and dissipates heat through its radiator.



A Cooling system in automobile



Central heating system

Q.5 Explain the volumetric thermal expansion.

Ans: Volume thermal expansion:

The volume of a solid also changes with the change in temperature and is called volume thermal expansion or cubical thermal expansion.

Consider a solid of initial volume V_o at certain temperature T_o. On heating the solid to a temperature T, let its volume becomes *V*, then

Change in the volume of a solid $\Delta V = V - V_o$ and Change in temperature $\Delta T = T - T_o$

Like linear expansion, the change in volume ΔV is found to be proportional to its original volume V_o and change in temperature ΔT. Thus $\Delta V \propto V_o \Delta T \Rightarrow$ or $\Delta V = \beta V_o \Delta T$ ..... (i)

or $V - V_o = \beta V_o \Delta T \Rightarrow$ or $V = V_o + \beta V_o \Delta T$

or $V = V_o(1 + \beta \Delta T)$ ..... (ii)

where β is the temperature coefficient of volume expansion. Using equation (i), we get

$$\beta = \frac{\Delta V}{V_o \Delta T} \quad \text{..... (iii)}$$

Coefficient of volume expansion β:

Thus, we can define the temperature coefficient of volume expansion β as the fractional change in its volume per kelvin change in temperature. The coefficients of linear expansion and volume expansion are related by the equation: $\beta = 3\alpha$ ..... (iv)

Q.6 Derive the relation for linear thermal expansion in solids.

OR Show that $L = L_o(1 + \alpha \Delta T)$?

Ans: Linear thermal expansion in solids:

Consider a metal rod of length L_o at certain temperature T_o. Let its length on heating to a temperature *T* becomes *L* Thus; Increase in length of the rod $= \Delta L = L - L_o$

Increase in temperature $= \Delta T = T - T_o$

It is found that change in length ΔL of a solid is directly proportional to its original length L_o, and the change in temperature ΔT. That is;

$\Delta L \propto L_o \Delta T \Rightarrow$ or $\Delta L = \alpha L_o \Delta T$ ..... (i)

or $L - L_o = \alpha L_o \Delta T \Rightarrow$ or $L = L_o + \alpha L_o \Delta T$

or $L = L_o(1 + \alpha \Delta T)$ ..... (ii)

Where α is called the coefficient of linear thermal expansion of the substance.

From equation (i), we get

$$\alpha = \frac{\Delta L}{L_o \Delta T} \quad \text{..... (iii)}$$